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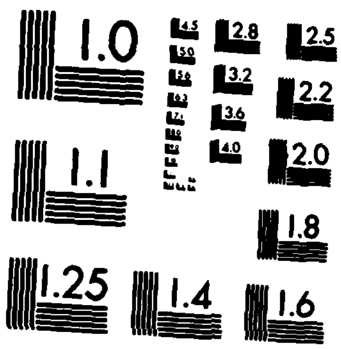

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PERIODONTAL WOUND HEALING RESPONSES TO VARYING OXYGEN CONCENTRATIONS AND ATMOSPHERIC PRESSURES

Michael Dean Shannon, M.S.

The University of Texas Graduate School of Biomedical Sciences at San Antonio

Supervising Professor: William W. Hallmon

Several studies using hyperbaric oxygen have shown accelerated connective tissue proliferation in wounded and compromised tissues. The purpose of this thesis ~~investigation~~ was to determine if increased postoperative oxygen and/or increased atmospheric pressure could enhance connective tissue healing responses following periodontal surgery. To test oxygen effects on a standardized periodontal wound, gingival wedge excisions were accomplished mesial to the maxillary right first molars of

205 Sprague-Dawley rats. Five animals were sacrificed immediately after the operation. Fifty operated controls were maintained at ambient atmospheric pressure in room air. Three experimental groups of fifty rats each were exposed for 90 minutes daily to one of the following: (a) 20% oxygen at 2.4 atmospheres pressure, (b) 100% oxygen at 1 atmosphere, or (c) 100% oxygen at 2.4 atmospheres. Animals were sacrificed in groups of 5 at 30 hours, 54 hours, 78 hours, and weeks 1, 2, 3, 6 and 12. Ten animals from each group were kept in reserve in case of mortality. Mesio-distal tissue sections from the operated right and unoperated left first molars were stained with hematoxylin and eosin. Histometric analysis was performed under 40 power light microscopy. The connective tissue healing above a reference notch on the mesial root was assessed by two-way analysis of variance.

Results confirmed previous studies which showed limited tissue coaptation before one week. ~~The~~ controls failed to show healing comparable to experimental animals until the end of two weeks. Enhanced connective tissue healing above the notch was most significant ($p \leq 0.05$) in the 2.4 atmospheres pressure groups at 3 and 6 weeks when compared to controls. There was also early enhancement of connective tissue healing with 100% normobaric oxygen, although this was no longer significant after two weeks. By 12 weeks, significant differences could not be detected. The earlier presence of connective tissue above the reference notch was not indicative of true attachment as a thin epithelial layer appeared between the tooth and connective tissue fibers at 12 weeks. New cementum formation was rare and occasional root resorption was observed. This study demonstrated that connective tissue healing can be initially enhanced by using hyperbaric pressure at 2.4 atmospheres with either 20% or 100% oxygen and to a lesser extent by 100% normobaric oxygen. However, early connective tissue adaptation does not necessarily imply eventual attachment as slow epithelial downgrowth progressively displaced the connective tissue adjacent to the root.

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PERIODONTAL WOUND HEALING RESPONSES TO VARYING OXYGEN CONCENTRATIONS AND ATMOSPHERIC PRESSURES

A THESIS

Presented to the Faculty of
The University of Texas Graduate School of Biomedical Sciences
at San Antonio
in Partial Fulfillment
of the Requirements
for the Degree of
MASTER OF SCIENCE

by

Michael Dean Shannon, B.S., D.D.S.

San Antonio, Texas
May, 1986

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PERIODONTAL WOUND HEALING RESPONSES TO VARYING

OXYGEN CONCENTRATIONS AND ATMOSPHERIC PRESSURES

Michael Dean Shannon

APPROVED:

________________, Supervising Professor

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DATE: May 23, 1986

APPROVED:

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Terry M. Mikiten, Ph. D., Associate Dean

DEDICATION

Dedicated to

Family and Friends,

whose sacrifice and support

made the last three years possible.

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*KEY: BD-CCT= base of defect to most coronal connective tissue.
BD-SB= base of defect to sulcus base.
BD-AB= base of defect to alveolar bone.
SB-CCT= sulcus base to most coronal connective tissue.
CCT-AB= most coronal connective tissue to alveolar bone.

List of Figures

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List of Plates

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Per Ms. June DeSouza, AFIT/NR

I. INTRODUCTION AND REVIEW OF THE LITERATURE

The effect of oxygen therapy on wound healing has been the focus of extensive scientific investigation. Early dental references to the treatment of "pyorrhea" with oxygen dealt with the introduction of oxygen into the periodontal pocket through a cannula (Dunlop, 1938) or by chemical means such as hydrogen peroxide (Orban, 1942). Glickman et al. (1949) noted greater oxygen consumption in inflamed gingiva compared to healthy gingiva. These early investigators were more interested in reporting on a therapeutic technique to treat and reverse a chronic inflammatory disease condition rather than demonstrating oxygen's effects on the actual biologic mechanisms of wound healing or the healing time. More recent dental and medical investigations, however, have concentrated on possible oxygen enhancement of wound healing, especially through the use of hyperbaric oxygen (HBO), i.e.: oxygen at pressures exceeding one atmosphere. However, the effects of HBO on the healing of periodontal tissues have received limited attention in the literature (Ivanov et al., 1979, Gotsko, 1980, Sumachev, 1983). A comprehensive literature review of this subject, therefore, will be considered under the following categories: A. studies of HBO effects on healing tissue and B. studies of periodontal wound healing, with regard to connective tissue reattachment at the dento-gingival junction.

A. HYPERBARIC OXYGENATION

Hyperbaric oxygenation was described as early as 1662 when Henshaw built the first recompression/ decompression chamber for therapeutic use (MacInnis, 1982). This actually preceded the discovery of oxygen by Sir Joseph Priestly in 1775 and led to the widespread use of compression chambers to aid treatment of a variety of ailments ranging from diabetes mellitus to syphilis. The first such chamber was built in the United States by Corning in 1891. In the 1930s, the American Medical Association challenged the use of hyperbaric oxygen, on the basis of insufficient animal and clinical studies. Thus, the popularity of this therapy started to wane. However the 1950s and early 1960s witnessed a reawakening of interest in hyperbaric oxygen therapy as scientific evidence mounted with regard to its effectiveness in specific medical conditions. By the mid-1970s, hyperbaric oxygenation was recognized as an effective treatment modality, primarily as a result of work summarized by Davis and Hunt (1975). The potentially toxic respiratory and neurologic effects of oxygen have been more clearly described (Scottish Health Services Council, 1969, Nishiki et al., 1976, Clark and Fisher, 1977, Deneke and Fanburg, 1980). Restricted daily oxygen exposure minimized these toxic effects. Marx and Ames (1982) indicated that the most beneficial hyperbaric pressure for humans is 2.4 atmospheres for 90 minutes after slow "descent" or gradual "dive" to this pressure.

Therapeutic application of hyperbaric oxygen has continued to flourish into the nineteen-eighties. Although hyperbaric oxygen therapy has primarily been directed toward wound healing, it has also been used to manage carbon monoxide poisoning (Myers et al., 1981) and anaerobic infection (Weinstein and Barza, 1976). Many of the wound healing studies have been involved with the effect of hyperbaric oxygen in the treatment of osteoradionecrosis (Greenwood and Gilchrist, 1973, Davis et al., 1979, Mansfield et al., 1981, Marx, 1983, Marx et al., 1985), osteomyelitis (Morrey et al., 1979, Kerley et al., 1981, Triplett et al., 1982) and burns (Korn et al., 1977, Niccole et al., 1977). These studies demonstrated HBO enhancement of fibroblastic activity, angiogenesis and neovascularization in "compromised" tissue, to ultimately promote healing. Furthermore, Wilcox and Kolodny (1976) observed a beneficial effect of HBO therapy during healing of osteotomies and "noncompromised" surgical wounds.

Hunt and Pai (1972) concluded that high oxygen tension levels positively enhanced fibroblastic activity. Hunt et al. (1967) also observed that a lower pH in a healing wound was indicative of a higher rate of local oxygen consumption with resultant increased production of carbon dioxide. In a later study, Hunt et al. (1969) also indicated that the addition of oxygen to the atmosphere increased the healing rate of open wounds. Niinikoski et al. (1972) supported these findings while studying tissue healing using wound oxygen tonometry. Remensnyder and Majno (1968) emphasized the importance of revascularization in rat cremaster muscle wounds, noting a lower oxygen tension and hypoxia in wounded tissue. Vaes and Nichols (1962) and Shaw and Bassett (1967) demonstrated decreased collagen production in bone and cartilage with reduced oxygen tension.

Marx (1983) proposed an explanation for the positive effects of hyperoxic therapy. Once hemoglobin has become saturated with oxygen, additional oxygen may be carried in the serum in physical solution. This may be accomplished by increasing the relative oxygen concentration, overall pressure, or both. Theoretically, 100% normobaric oxygen would yield a seven fold increase in per cent volume over room air, and 100% hyperbaric oxygen at 2.4 atmospheres would yield approximately eighteen times the per cent volume of oxygen in solution as room air. These calculations are based upon the measured $PaO2$ of 100 mmHg for room air, 673 mmHg for normbaric oxygenation, and 1,795 mmHg for hyperbaric oxygenation, multiplied by the solubility constant, 0.0031 ml $O2$/100 ml blood/1mmHg $PaO2$. The application of these facts to wound healing appears related to the hydroxylation of proline and lysine in collagen synthesis (Hunt et al., 1977). Hydroxylation of proline and lysine is a prerequisite for tropocollagen formation, the collagen molecule and eventual collagen fiber synthesis. Hypoxia slows hydroxylation while hyperoxia enhances it.

Conflicting effects of oxygen therapy in wound healing have been described. Lundgren and Sandberg (1965) observed the effects of multiple daily doses of hyperbaric oxygen on experimental skin wounds in rats. They found that hyperbaric oxygen decreased wound tensile strength, which is thought to be dependent upon hydroxyproline content in collagen. They speculated that this impairing effect was dose dependent and related to blood flow. Niinikoski et al. (1966) and Kulonen et al. (1967) initially studied the effect of normobaric oxygen at high concentrations and observed little wound healing enhancement. These investigators subsequently reported beneficial effects using hyperbaric oxygen (Niinikoski et al., 1970). Hunt concluded that, "The vital argument, at this time, would seem to be not whether added oxygen can be useful in the treatment of certain disorders of repair but the extent to which oxygen must be delivered to produce the desired effect" (Hunt et al., 1977).

B. PERIODONTAL WOUND HEALING STUDIES

In reviewing periodontal wound healing, Stahl (1964, 1977a) described gingival healing in Sprague-Dawley rats following removal of mesial marginal tissue of the maxillary first molar. A distinct interface between the gingival wound and the severed supracrestal fibers was seen by one week following surgery. Where cementum and attached fibers were removed, an altered epithelial adherence was usually seen. This altered adherence presented either as a long or a short junctional epithelial attachment coronal to parallel oriented collagen fibers which appeared to adhere to the tooth surfaces. In speculating on gingival repair, Stahl et al. (1972) discussed four possible schema of soft tissue/tooth healing: 1.) apical migration of the epithelial cuff, 2.) healing by scar, 3.) repair by collagen adhesion and 4.) cemental repair and reattachment. They discussed various host and local factors that may influence the types of repair. Regeneration of fibrous attachment to cementum would be the optimal but not a uniformly predictable goal (Stahl, 1975, 1977b).

In a recent overview on peridontal attachment, Stahl (1985) described a possible sequence of mechanisms controlling new attachment: 1.) a reduction of inflammation allowing for linkage of new gingival fibrils with cemental fibrils; 2.) a long junctional epithelial adhesion may occur covering plaque-free exposed cementum; 3.) inflammation may be severe enough to cause root resorption into dentin, allowing linkage of dentinal collagen with gingival collagen; or 4.) new attachment may take place following regenerative therapy, consisting of new cementum and fiber apparatus connecting to bone. A variety of tissue responses may occur within a single lesion.

Stern (1981), Wirthlin (1981) and Barrington (1981) also reviewed healing following new attachment procedures. They described a new dento-gingival junction of a long epithelial attachment supported by a healthy collagenous connective tissue, which is longitudinally functional and maintainable. Using marmosets and electromicroscopy, Taylor and Campbell (1972) provided a daily account of gingival epithelial reattachment, reassuring that if separation occurs, attachment may be renewed cervico-occlusally within five days. Sabag et al. (1984) have observed similar epithelial healing following gingivectomy in the rat. Ultrastructural studies by Listgarten (1972) and Marikova (1983) confirm these findings.

Linghorne and O'Connell (1955) and Marfino et al. (1959) provided conflicting reports of gingival healing in dogs. The former authors theorized that the long epithelial attachment could be progressively displaced by connective tissue while the latter disputed these findings. Marfino, Orban and Wentz described apical progression of epithelium with time. They considered this a functionally acceptable repair of the dento-gingival junction since total regeneration of the original morphology failed to occur in the long epithelial attachment. Wilderman et al. (1960) and Hiatt et al. (1968) also reported long junctional epithelial healing following surgery in dogs.

Caton and coworkers (1979, 1980a, 1980b) have histometrically studied the attachment between tooth and gingival tissues in nonhuman primates. They suggested that previous animal models may have contributed to confusion concerning patterns of dento-gingival repair. Following a variety of surgical procedures including curettage, modified Widman flaps, red marrow autogenous osseous grafts and tricalcium phosphate alloplastic grafts, the authors demonstrated a long junctional epithelial attachment following all types of surgical regenerative procedures with no new connective tissue attachment.

Bowers et al. (1982) did show cementum formation and the possibility of new attachment in intrabony defects in man following osseous grafting. This was recently confirmed in human subjects (Bowers et al., 1985) using demineralized freeze-dried bone both with and without root submergence. New attachment to pathologically exposed roots was also obtained by submergence alone, without grafting, but did not occur on nonsubmerged, nongrafted pathologically exposed roots that served as surgical controls.

Listgarten and Rosenberg (1979) noted the presence of a long junctional epithelium in humans following osseous grafting procedures and discussed the role of oral hygiene in this occurrence. Frank et al. (1972, 1974) have also studied human histologic material following flap procedures indicating healing by long junctional epithelial attachment except at the most apical level where connective tissue attachment was present in notches resulting from instrumentation. Garrett et al. (1981) reviewed the effect of notching into dentin and found no effect on the rate or quantity of new cementum formation in beagle dogs. Other studies in man generally confirm that a long junctional epithelium is the consequence of periodontal surgery (Levine and Stahl, 1972, Yukna et al., 1976, Svoboda et al., 1984, Yumet and Polson, 1985). However, Nyman et al. (1982b) interposed a milli-pore filter between a flap and the tooth surface in a human case report and obtained connective tissue regeneration. Presumably, epithelial and gingival connective tissue exclusion allowed periodontal ligament cells to repopulate the wound and to regenerate a new attachment.

Numerous other attempts to promote connective tissue attachment in lieu of a long junctional epithelial attachment appear in the literature. Aleo et al. (1975) and Wirthlin and

Hancock (1980) have emphasized the biologic preparation of the root surface to remove contaminants and to provide conditions which favor connective tissue attachment. Ellegaard et al. (1976) used connective tissue grafts to exclude apically proliferating epithelium, while Yaffe et al. (1984) used an enriched collagen solution on roots to accomplish the same result.

Equivocal observations exist regarding the beneficial effects of citric acid in promoting connective tissue attachment (Stahl and Froum, 1977, Cole et al., 1980, Froum et al., 1983, Woodyard et al., 1984, Nyman et al., 1985). Cafesse et al. (1985) enhanced connective tissue attachment with citric acid conditioning of root surfaces followed by fibronectin application, although all animals were sacrificed at six weeks which may not be indicative of the long term effect. It is interesting to note that Glass et al. (1984) reported that there is an increase in serum fibronectin with 100% normobaric (1 atmosphere) and hyperbaric (4 atmospheres) oxygen exposure in Sprague-Dawley rats up to 2.5 times that of control animals.

In a series of studies (Karring et al., 1980, Gottlow et al., 1984, Karring et al., 1984), a Scandinavian group defined the role of the periodontium in relation to root resorption and attachment following surgery. Epithelial cells can serve as a buffer between the root and the potentially resorptive capacity of bone and connective tissue cells. While Lopez (1984) has observed resorption on roots implanted in alveolar mucosa, he disputed the need for adjacent progenitor cells from the periodontal ligament. He proposed that it was the condition of the root surface, rather than the lack of progenitor cells, that limits new connective tissue attachment. However, it seems clear that the periodontal ligament cells provide a major source of connective tissue attachment and regeneration (Nyman et al., 1982a, Karring et al., 1985).

There is some question as to the importance of distinguishing between healing and radicular attachment by connective tissue or long junctional epithelium. Traditionally, it has been accepted that connective tissue attachment would physically resist inflammation more effectively than a long epithelial attachment (Armitage et al., 1977, Moskow et al., 1979, Woodyard et al., 1984). However, Magnusson et al. (1983) surgically created a long junctional epithelial attachment in monkeys, allowing plaque accumulation for six months following a four month healing period. The results of that study indicated that a long junctional epithelial attachment could function as a barrier against plaque infection as well as a dentogingival connective tissue unit. Beaumont et al. (1984) also observed no difference in resistance to inflammation between a surgically induced long junctional epithelial attachment and naturally occurring connective tissue attachment. However, these findings were based on artificially created periodontitis in very young beagle dogs and the disease recurrence phase was only twenty days.

In a study with particular relevance to this investigation, Listgarten et al. (1982) demonstrated that over a twelve month postsurgical healing period, gingival connective tissue can coronally displace an initially formed long junctional epithelial attachment in rats. His finding disputes the established concept that initial healing by a long junctional epithelial attachment, once formed, is a lasting histological entity. Perhaps an altered oxygen environment may positively enhance connective tissue fibroblast activity to limit the apical extent of the epithelial attachment or to accelerate the later connective tissue replacement of the initial long epithelial attachment.

C. STATEMENT OF PROBLEM

This study examines the effect of hyperbaric and normobaric oxygenation on periodontal wound healing, using the Sprague-Dawley rat as a model. Specifically, research objectives were:

1. To determine if healing by connective tissue attachment can be enhanced and the apical extent of junctional epithelial attachment diminished by increasing the amount of soluble oxygen in the blood.

2. To compare the effects of two oxygen concentrations at normal and high pressure on wound healing.

3. To determine if coronal migration of connective tissue attachment will proceed at an accelerated rate under these conditions.

D. NULL HYPOTHESIS

There will be no difference in connective tissue healing after periodontal surgery between control and oxygen enhanced experimental groups.

II. MATERIALS AND METHODS

A. STUDY POPULATION

Experimental subjects were 205 adult (300-375 gram, approximately 12-16 months old) male Srague-Dawley rats. The animals were divided into five groups. Five animals (Group A) represented time zero and provided a base line reference. The remaining animals were divided into four groups (B, C, D, and E) each containing fifty animals. Data was collected from forty subjects in each group with ten remaining animals reserved for use in the event of experimental loss. The reserve animals were subjected to the same postoperative therapy as their respective experimental groups. Since no unscheduled animal death occurred during the postoperative period, all of the reserve animals were returned to the Clinical Investigation Facility animal pool.

B. SURGICAL TECHNIQUE

Surgical procedures were accomplished for the respective experimental groups on five separate days. All 205 animals were anesthetized with intraperitoneal injection of 20 mg of sodium pentobarbital and 0.4 mg of atropine sulfate. A standardized mesial wedge of epithelium and connective tissue was removed adjacent to the maxillary right first molar of all animals (see

Figure 1.). A triangular metal template measuring 1.0 mm at its base and 1.5 mm in height was used as a guide. The surface of the prominent mesial root was root planed to remove fiber tags and coronal cementum. A horizontal notch was made in the root at the height of the alveolar crest using a number 15 Bard-Parker blade. The blade was placed between tooth and bone and traversed the root once, leaving a notch approximately 50-100 microns in vertical height. The bottom of this notch represented the base of the surgical defect (BD). No sutures were placed. The left side served as an unoperated internal control.

C. EXPERIMENTAL DESIGN

Group A animals were sacrificed with a sodium pentobarbital overdose immediately after the intra-oral procedure. Postoperatively, Group B animals recovered at normal room air pressure (approximately 1 atmosphere) and approximately 20.8% oxygen tension. Group C animals experienced ambient room air at 2.4 atmospheres for 90 minutes daily until sacrifice. Group D animals were given 100% oxygen under normobaric pressure (1 atmosphere) for 90 minutes daily until sacrifice. Group E animals were given 100% oxygen under hyperbaric pressure (2.4 atmospheres) for 90 minutes daily until sacrifice. (See Table 1.)

Postoperative therapy began the morning of the first

FIGURE 1. DIAGRAM OF INTRAORAL WOUND, MAXILLARY RIGHT FIRST MOLAR

Figure 1

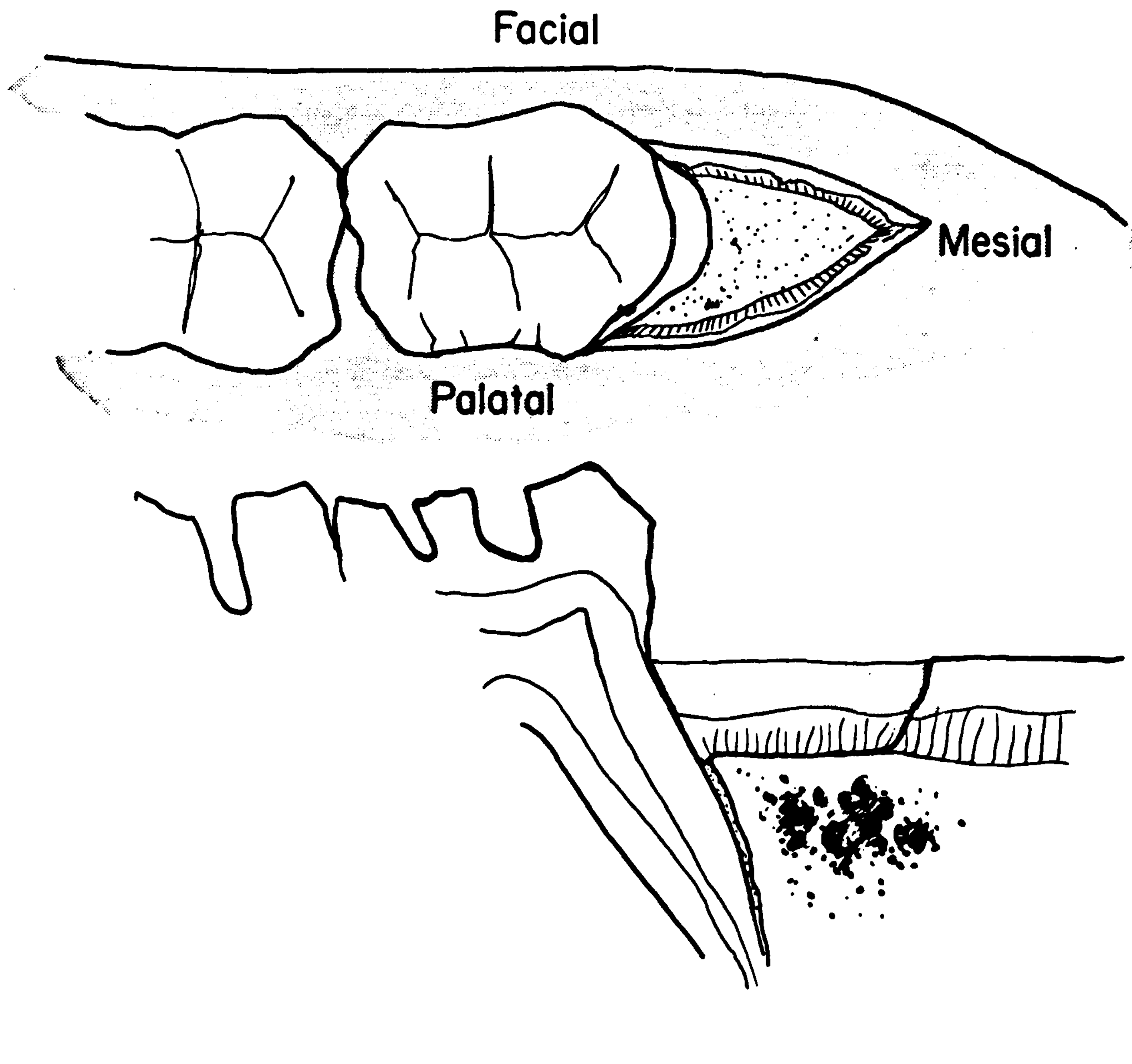


TABLE 1. SUMMARY OF POSTOPERATIVE

TREATMENT CONDITIONS

GROUP A, 5 ANIMALS	NO POSTOPERATIVE TREATMENT, IMMEDIATE SACRIFICE.
GROUP B, 50 ANIMALS	20.8% OXYGEN, 1 ATMOSPHERE (ROOM ATMOSPHERE)
GROUP C, 50 ANIMALS	20.8% OXYGEN, 2.4 ATMOSPHERES FOR 90 MINUTES/DAY
GROUP D, 50 ANIMALS	100% OXYGEN, 1 ATMOSPHERE FOR 90 MINUTES/DAY
GROUP E, 50 ANIMALS	100% OXYGEN, 2.4 ATMOSPHERES FOR 90 MINUTES/DAY

post-operative day. All animals were fed the same diet of commercial lab chow and water ad libitum. Treatment and care of all animals was conducted humanely in accordance with Air Force regulation, AFR 169-2.

Five animals from each group (B, C, D, and E) comprised a subgroup and were sacrificed by means of carbon dioxide suffocation at 2:00 PM at the following time periods: 30 hours, 54 hours, 78 hours, 1 week, 2 weeks, 3 weeks, 6 weeks and 3 months. After sacrifice, the skulls were defleshed and placed in 10% neutral buffered formalin for fixation. After decalcification for approximately 1 week in 22.5% formic acid and 10% sodium citrate (AFIP Manual, 1968), block sections of the right and left first molar and surrounding tissue were obtained. Following processing and paraffin embedding, serial sections, 5-6 microns thick, were made in a mesio-distal direction approximating the notched, mid-root areas. Specimens were mounted on slides and stained with hematoxylin and eosin. Selected slides were stained with Movat's pentachrome stain to confirm examiner ability to locate the extent of junctional epithelium. At least five slides, 15-20 microns apart, were prepared from each tissue block. For each animal two representative slides from the surgical and control sites were submitted for histometric evaluation.

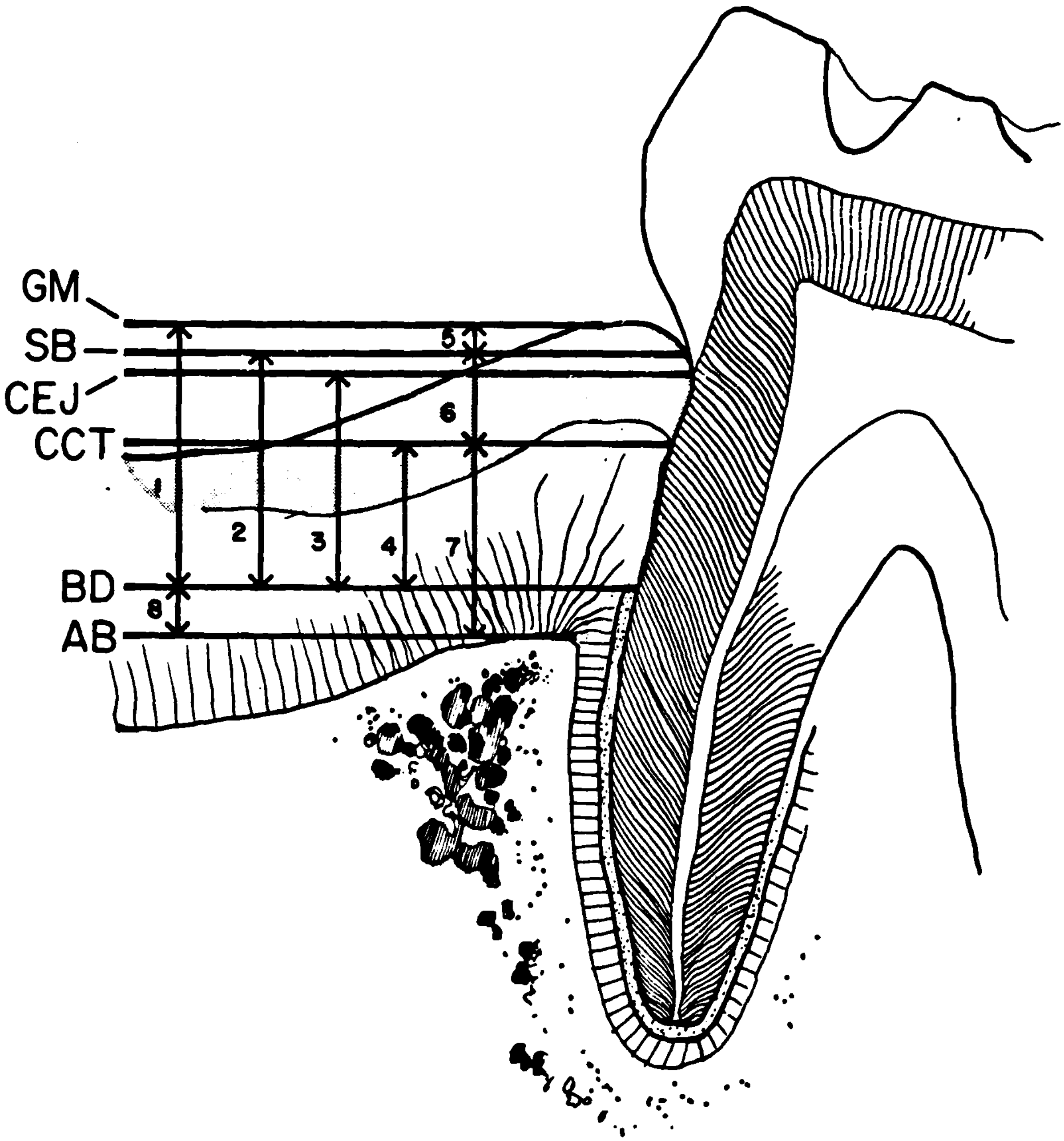
D. METHOD OF EVALUATION

A microscope (American Optical One-Ten, dual binocular) equipped with a calibrated linear micrometer eyepiece (each eyepiece mark = 20 microns) was used at 40 power. Histometric parameters from the two representative slides from each site were measured and their average values recorded. The blinded investigator was not aware of the method of postoperative therapy at the time of measurement and the order of postoperative time interval was randomly selected for analysis to prevent examiner bias. The notch BD provided a reference point on the surgically treated specimens for measuring the extent of junctional epithelial attachment and connective tissue attachment. Other anatomical distances were recorded to provide reference for other detectable changes (see Figure 2). If the tissue had not reestablished contact with the tooth at the early stages of healing, no measurement was recorded. Measurements on the unoperated sides provided reference of the normal dento-gingival relationship and served as a control for aging effects. Incorrect tissue orientation or improper sectioning represented sources of technical error. This resulted in loss of some specimens so that only four out of five blocks were acceptable for evaluation in certain day groups.

FIGURE 2. DIAGRAM OF HISTOMETRIC DISTANCES MEASURED:

1. BD-GM, BASE OF DEFECT TO GINGIVAL MARGIN
2. BD-SB, BASE OF DEFECT TO SULCUS BASE
3. BD-CEJ, BASE OF DEFECT TO CEMENTO-ENAMEL JUNCTION
4. BD-CCT, BASE OF DEFECT TO MOST CORONAL CONNECTIVE TISSUE
5. SB-GM, SULCUS BASE TO GINGIVAL MARGIN
6. CCT-SB, MOST CORONAL CONNECTIVE TISSUE TO SULCUS BASE
7. AB-CCT, ALVEOLAR BONE TO MOST CORONAL CONNECTIVE TISSUE
8. BD-AB, BASE OF DEFECT TO ALVEOLAR BONE

Figure 2



Histometric measurements were subjected to two way analysis of variance. If overall analysis of variance was statistically significant at $p \leq .05$, Fischer's least significant difference post hoc test was used to determine which groups differed at $p \leq .05$. The proportion, connective tissue above the notch (BD-CCT) divided by epithelial attachment length plus connective tissue attachment (BD-SB), was used for statistical analysis in order to account for any variation in the size of the animal and the depth of the experimental wound. Fischer's least significant difference values were: 0.260 for groups of 4 vs. 5; 0.243 for groups of 5 vs. 5; and 0.270 for groups of 5 vs. 4.

III. RESULTS

A positive qualitative difference in healing was noted between the groups that experienced postoperative conditions at 2.4 atmospheres (Groups C and E) and those that experienced normobaric postoperative conditions (Groups B and D). The former exhibited more advanced healing at the early time intervals, while the latter appeared to exhibit a long junctional epithelial attachment more readily. Quantitatively, the proportion of connective tissue and epithelial attachment for Groups C and E was significantly different from control Group B ($p \leq 0.5$) at three and six weeks (see sample calculation, Figure 3). Group D, 100% normobaric oxygen, also demonstrated a statistically significant difference from controls at weeks 1 and 2. However by twelve weeks, there were no significant differences in the type of dentogingival attachment among the four groups (B, C, D and E). The nature of this attachment was usually a long junctional epithelium (see Tables 2 and 3). As seen in figures 4 and 5, by converting the absolute values in microns to a proportion of connective tissue and epithelium, the relative amounts of these tissue components are derived.

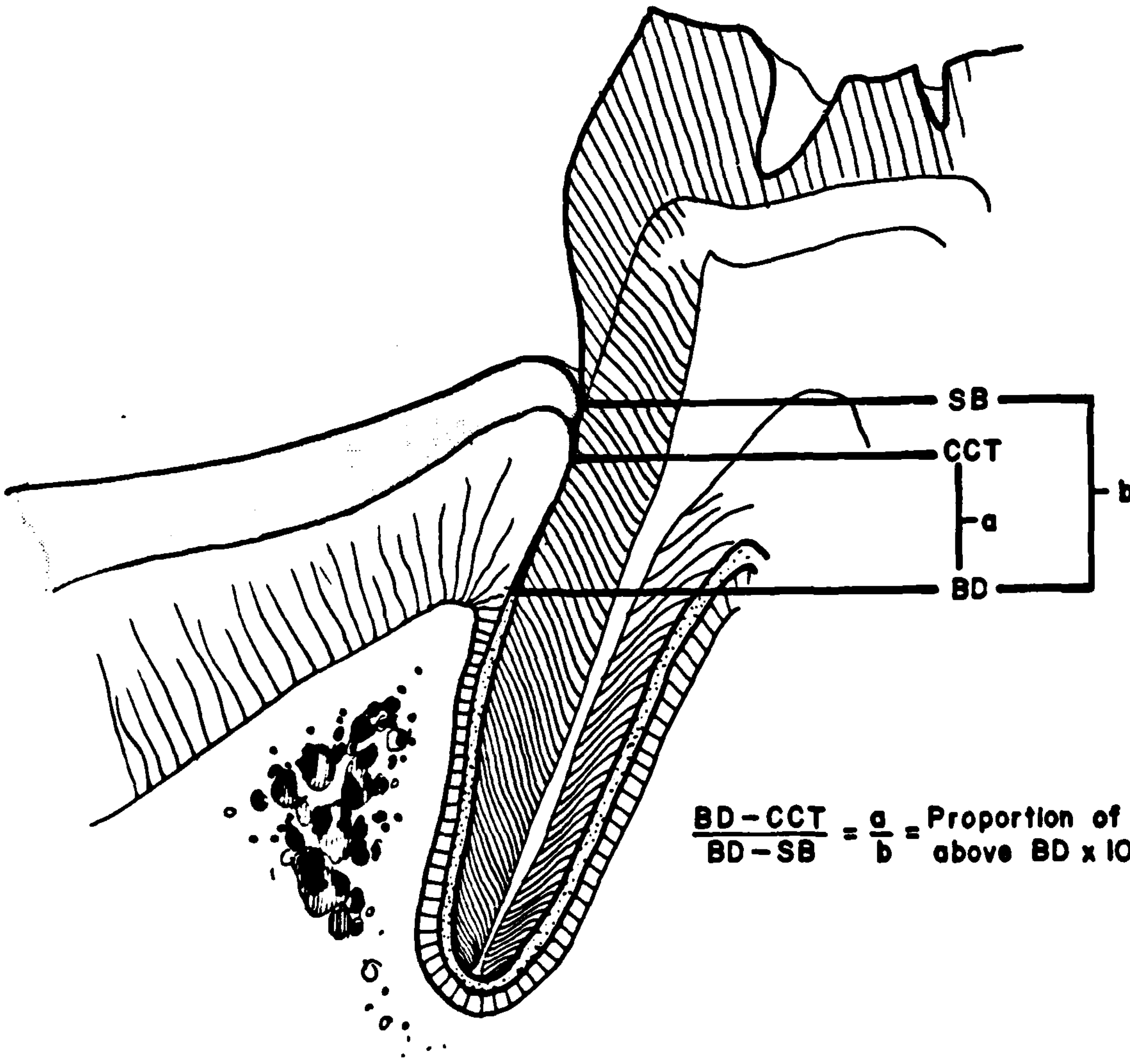
Thus coronal displacement of the epithelial attachment by connective tissue was not observed within the 12 week experimental period. In fact, a trend for apical displacement of

FIGURE 3. SAMPLE CALCULATION OF THE PROPORTION OF CONNECTIVE TISSUE HEALING ABOVE BASE OF DEFECT.

Figure 3

Sample Calculation:

Proportion of connective tissue healing above base of defect (BD)



$$\frac{BD-CCT}{BD-SB} = \frac{a}{b} = \text{Proportion of CCT above BD} \times 100 = \text{\% of Healin}$$

Key: SB = Sulcus Base

CCT = Most Coronal Connective Tissue

BD = Base of Defect

TABLE 2. MEASUREMENT OF CONNECTIVE TISSUE DIVIDED BY CONNECTIVE TISSUE PLUS JUNCTIONAL EPITHELIUM ABOVE BASE OF DEFECT (numerator= connective tissue above base of defect, BD-CCT; denominator=connective tissue plus junctional epithelium, BD-SB; scale= microns; dash= missing value due to technical error)

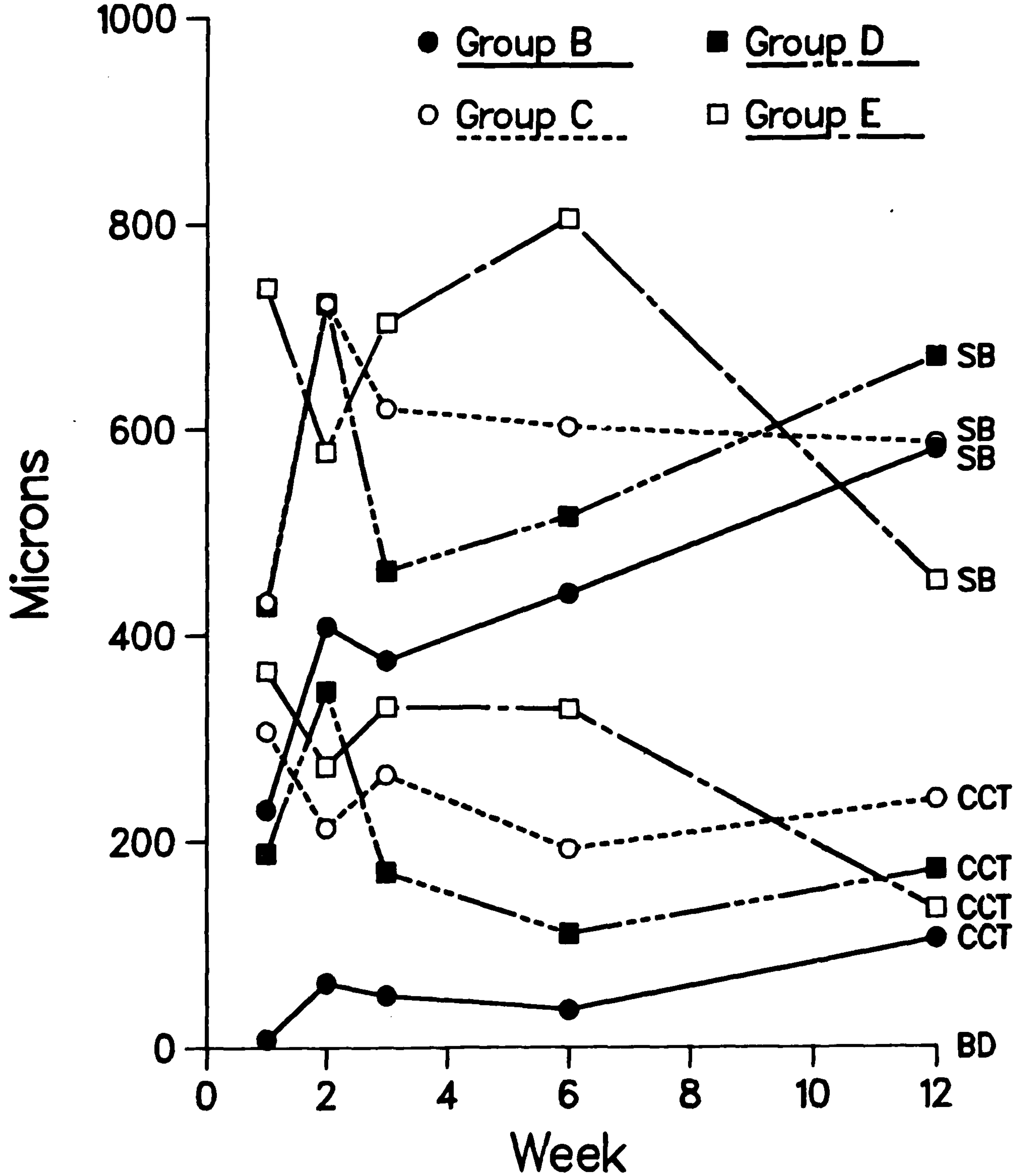
	GROUP B CONTROL RM. AIR	GROUP C 20.8% O2 2.4 ATM.	GROUP D 100% O2 1 ATMOS.	GROUP E 100% O2 2.4 ATM.
WEEK 1	-	320/450	340/700	260/510
	0/170	460/640	200/450	-
	0/300	100/430	250/440	200/470
	30/230	130/640	150/380	1220/1670
	0/220	520/680	0/170	40/300
ave.	7.5/230	306/432	188/428	365/737.5
WEEK 2	0/330	330/800	200/420	50/220
	20/500	100/590	210/640	220/650
	170/440	-	570/1010	530/980
	60/330	0/720	-	290/590
	60/440	420/780	400/820	270/450
ave.	62/408	212.5/722.5	345/722.5	272/578
WEEK 3	20/420	710/1090	240/510	420/800
	-	90/530	140/320	310/560
	50/310	240/510	250/440	300/520
	40/320	280/400	-	420/860
	90/450	0/570	50/580	200/780
ave.	50/375	264/620	170/462.5	330/704
WEEK 6	0/400	280/530	70/320	410/800
	70/550	0/670	-	-
	0/310	0/660	0/580	360/860
	40/490	470/810	120/610	320/750
	70/450	210/340	250/550	220/810
ave.	36/440	192/602	110/515	327.5/805
WEEK 12	-	100/490	270/830	140/360
	0/440	150/470	460/1000	230/560
	50/400	540/840	50/310	110/480
	230/650	100/430	0/860	150/470
	140/830	310/700	80/350	40/390
ave.	105/580	240/586	172/670	134/452

TABLE 3. PROPORTION OF CONNECTIVE TISSUE ABOVE BASE OF DEFECT, SUBGROUP MEANS OF BD-CCT DIVIDED BY BD-SB

	GROUP B CONTROL RM. AIR	GROUP C 20.8% O2 2.4 ATM.	GROUP D 100% O2 1 ATMOS.	GROUP E 100% O2 2.4 ATM.
WEEK 1	0.03261 ±0.06522	0.52605* ±0.28229	0.37862* ±0.22099	0.44980* ±0.24709
	(3%)	(53%)*	(38%)*	(45%)*
WEEK 2	0.14891 ±0.15138	0.28011 ±0.24150	0.46412* ±0.09874	0.43962* ±0.15328
	(15%)	(28%)	(46%)*	(44%)*
WEEK 3	0.13348 ±0.06492	0.39836* ±0.30461	0.39062 ±0.21039	0.48006* ±0.12932
	(13%)	(40%)*	(39%)	(48%)*
WEEK 6	0.07289 ±0.07158	0.34524* ±0.31675	0.21750 ±0.31675	0.40734* ±0.09997
	(7%)	(35%)*	(22%)	(41%)*
WEEK 12	0.16188 ±0.14659	0.36830 ±0.17941	0.23503 ±0.17283	0.29010 ±0.12652
	(16%)	(37%)	(24%)	(29%)

sig. difference from control group B denoted by *, $p \leq .05$

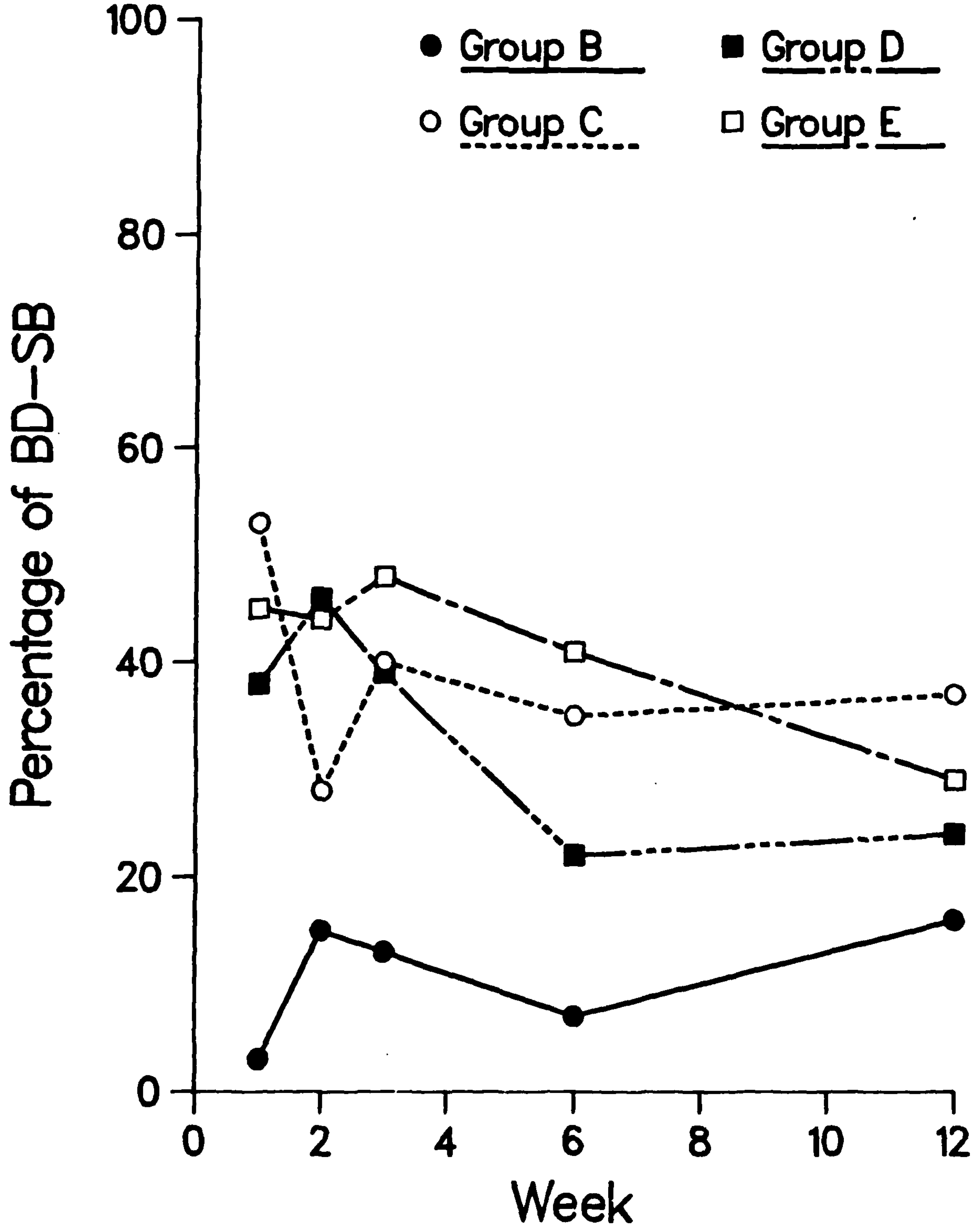
FIGURE 4. GRAPH OF CONNECTIVE TISSUE (BD-CCT) AND JUNCTIONAL EPITHELIUM (CCT-SB) IN MICRONS.



Microns
1000
800
600
400
200
0
Group B
Group C
Group D
Group E
SB
SB
SB
SB
CCT
CCT
CCT
CCT
BD
0
2
4
6
8
10
12
Week

Shannon 2

FIGURE 5. GRAPH OF PROPORTION OF CONNECTIVE TISSUE HEALING ABOVE BASE OF DEFECT AS A PERCENTAGE OF BD-SB.



Group B
Group D
Group C
Group E
100
80
60
40
20
0
Percentage of BD–SB
0
2
4
6
8
10
12
Week

Shannon 1

connective tissue by epithelium appeared to occur. Results relating to observed trends are most easily presented by designated experimental time intervals:

TIME ZERO

Information from Group A (five animals sacrificed immediately after the intra-oral procedure) indicated that it was not always possible to place the base of defect mark (BD) at the crest of alveolar bone (AB), due to mechanical limitations of the instrumentation. A microscopic distance between BD and AB was usually apparent (see Tables 4 and 5).

30, 54 AND 78 HOURS

Early attachment and/or apposition of gingival tissue was not seen in any groups during these time periods. However granulation tissue appeared to be arising from wound edges and the periodontal ligament, indicating that connective tissue proliferation was occurring in advance of epithelial proliferation (see Plate 1).

ONE WEEK

At one week, tissue adaptation had occurred next to the

TABLE 4. DISTANCE FROM BASE OF
DEFECT TO ALVEOLAR BONE, BD-AB
(scale= microns; dash= missing value due to technical error)

	GROUP B	GROUP C	GROUP D	GROUP E
DAY 1	230	250	120	200
	60	150	90	160
	190	230	120	380
	150	90	200	380
	250	60	100	260
DAY 2	180	100	170	90
	140	190	200	240
	90	150	90	200
	100	0	150	200
	240	120	130	280
DAY 3	120	110	160	260
	200	200	120	280
	-	120	-	300
	300	220	710	100
	300	200	160	220
WEEK 1	-	110	240	300
	230	300	460	-
	270	310	440	480
	330	330	300	400
	220	320	360	570
WEEK 2	480	400	870	640
	400	520	390	460
	540	-	410	580
	350	420	-	530
	520	700	550	460
WEEK 3	400	320	400	360
	-	620	800	430
	520	480	540	470
	340	380	-	390
	510	410	380	500
WEEK 6	460	320	460	600
	340	390	-	-
	390	630	640	500
	410	570	750	400
	540	440	500	600
WEEK 12	-	430	450	620
	400	470	240	270
	570	420	780	630
	710	640	670	650
	640	630	770	650

TABLE 5. SUBGROUP MEANS OF DISTANCE FROM BASE OF DEFECT TO ALVEOLAR BONE, BD-AB

(scale= microns; *= greater than 1 S.D. above overall mean #= greater than 1 S.D. below overall mean)

	GROUP B CONTROL RM. AIR	GROUP C 20.8% O2 2.4 ATM.	GROUP D 100% O2 1 ATMOS.	GROUP E 100% O2 2.4 ATM.
DAY 1	176±75.4#	156±83.6#	126±43.4#	276±101.4
DAY 2	150±61.6#	112±71.2#	148±41.4#	202±70.8
DAY 3	230±87.2	170±51#	287.5±282	232±79.4
WEEK 1	262.5±50	274±92.4	360±92.8	437.5±115
WEEK 2	458±80.8	510±137.2	555±221.8*	534±78
WEEK 3	442.5±87.4	442±115	530±193.6	430±57
WEEK 6	428±76	470±127.8	587.5±132*	525±95.8
WEEK 12	580±133*	518±108.4	582±232.8*	604±76*

PLATE 1. CONNECTIVE TISSUE PROLIFERATION AT 72 HOURS. (Note granulation tissue from lateral and mesial wound edges; little proliferation is evident from the periodontal ligament.)

root allowing histometric measurement, although true adhesion or attachment was difficult to judge histologically. Artifactual separations were common and consistent with the early stage of healing. (See Plate 2.) These separations were usually parallel to the root surface and did not interfere with linear measurements. The control group B appeared to be at a less advanced stage of healing at one week as evidenced by a significantly greater percent connective tissue-tooth interface in Groups C (53%), D (38%) and E (45%) compared to Group B (3%). (See Table 3.)

TWO WEEKS

By two weeks healing was comparable among all groups with regard to wound maturation. However considerably less connective tissue was present adjacent to the instrumented root in control Group B (15%), compared to Group C (28%), Group D (46%) and Group E (44%). There was a statistical difference only between Group B and Groups D and E. Most control specimens demonstrated a long junctional epithelial interface extending to the notched area (Plate 3). In comparison, the experimental groups demonstrated approximately 2-3 times more connective tissue adjacent to the root above the notch (Plate 4). Note the elongation of a thin junctional epithelial interface seen in a two week Group D specimen (Plate 5), perhaps representing an initial epithelial

PLATE 2. ARTIFACTUAL SEPARATION OF SOFT TISSUE AT ONE WEEK.
(Note resorptive bay and presence of multinucleated cell)

PLATE 3. LONG JUNCTIONAL EPITHELIUM TO BASE OF NOTCH IN CONTROL ANIMAL AT TWO WEEKS.
(Note remaining epithelial cells attached to root after artifactual separation)

PLATE 4. EXAMPLE OF GROUP E HEALING AT TWO WEEKS.
(Note approximately half connective tissue and half epithelium comprising the soft tissue interface above the notch; also note the presence of inflammatory cells in the area of the notch)

PLATE 5. EXAMPLE OF GROUP D HEALING AT TWO WEEKS.
(Note the elongating portion of the junctional epithelium)

apical progression.

THREE AND SIX WEEKS

Control Group B continued to demonstrate a longer junctional epithelial attachment compared to experimental groups. The connective tissue adaptation above the notch was significantly greater ($p \leq 0.05$) than controls for the hyperbaric oxygen groups only: Group C (40% at 3 weeks, 35% at 6 weeks) and Group E (48% at 3 weeks and 41% at 6 weeks). (See Plate 6.) Although, Group D still had three times the connective tissue adaptation above the notch as the controls, this was no longer statistically significant (39% at 3 weeks and 22% at 6 weeks) compared to Group B (13% at 3 weeks and 7% at 6 weeks). At this time though, note the apically progressing, thin epithelium and the artifactual space perhaps due to weak connective tissue adaptation present in a hyperbaric, 20% oxygen, Group C specimen (Plates 7a and 7b).

TWELVE WEEKS

At the final sacrifice period of 12 weeks, there was no statistical difference between any of the groups B, C, D or E. In Group C, 20% oxygen at 2.4 atmospheres, a 37% connective tissue adaptation persisted but was not significantly different from the control group B with 16%. Group D and Group E demonstrated

PLATE 6. EXAMPLE OF GROUP E HEALING AT THREE WEEKS.
(Note approximately half connective tissue and half epithelium comprising the soft tissue interface above the notch; note also the maturation of the connective tissue and relative lack of inflammatory cells.)

PLATE 7a. EXAMPLE OF GROUP C HEALING AT 6 WEEKS. (X 100)

(Note strands of lateral proliferating epithelium with inflammatory cell infiltrate)

PLATE 7b. EXAMPLE OF GROUP C HEALING AT 6 WEEKS (X 200)

24% and 29% connective tissue interface above the base of the notch respectively, a trend indicating slow replacement of the connective tissue adjacent to the root by an apically proliferating epithelium (Plate 8). The trend of increased distance from the base of defect to alveolar bone (BD-AB) continued in all groups, indicating probable bone resorption over the twelve weeks (see Table 5).

UNOPERATED LEFT SIDE

There were no significant changes over time or among groups in the unoperated left side internal controls (See Plate 9). When comparing the ratio of junctional epithelial attachment to connective tissue above bone (SB-CCT divided by CCT-AB, Tables 6 and 7), only three random subgroups were one standard deviation from the overall mean. This indicates relative stability of the unoperated dentogingival complexes.

It is interesting to note in table 8, that when the ratios of junctional epithelium to total connective tissue attachment are compared for right and left sides, Groups B and D established the the same ratio by twelve weeks on both sides (approx. 2:3). The hyperbaric groups C and E, had a greater proportion of total connective tissue above bone at twelve weeks (approx. 2:5) compared to both the unoperated left sides and the normobaric groups (Table 8). However, this result must be

PLATE 8. EXAMPLE OF GROUP E HEALING AT 12 WEEKS.
(Note epithelium approaching remodeled notch area where it is halted by connective tissue in resorptive bay.)

PLATE 9. EXAMPLE OF UNOPERATED LEFT SIDE,
GROUP E ANIMAL AT 2 WEEKS

(Note fold of sulcular epithelium, commonly present in unoperated specimens)

TABLE 6. UNOPERATED LEFT SIDE, EPITHELIUM (SB-CCT)/CONNECTIVE TISSUE (CCT-AB)
(scale= microns; dash= missing value due to technical error)

	GROUP B	GROUP C	GROUP D	GROUP E
DAY 1	320/590	370/450	490/680	520/700
	340/530	340/490	490/690	270/1120
	220/650	390/640	-	620/720
	300/540	760/400	400/620	400/770
	300/680	580/610	380/710	350/510
DAY 2	330/690	300/610	350/730	440/760
	370/640	380/680	490/560	420/800
	420/710	340/530	550/800	-
	420/820	550/470	420/800	560/640
	360/970	390/720	520/660	400/500
DAY 3	460/1140	370/740	320/360	300/300
	120/1020	210/510	180/950	480/630
	180/870	280/670	240/800	390/650
	120/1000	440/680	420/600	400/610
	100/970	270/800	490/700	320/660
WEEK 1	300/400	410/510	380/500	380/650
	-	400/500	430/530	360/680
	300/700	470/670	430/600	470/800
	300/400	270/650	550/840	390/930
	470/470	380/610	180/850	370/820
WEEK 2	400/620	560/840	420/720	530/660
	230/530	540/540	570/300	360/820
	320/460	200/550	390/820	290/670
	280/540	560/660	440/510	290/730
	-	500/550	620/620	350/690
WEEK 3	250/430	380/480	-	340/690
	320/3400	210/610	230/840	430/700
	-	310/370	490/630	390/650
	140/620	240/880	280/700	260/900
	290/700	-	300/400	400/740
WEEK 6	200/400	380/700	420/800	520/660
	340/400	370/640	360/780	300/730
	200/700	480/640	620/510	490/790
	280/420	260/660	440/780	660/860
	240/300	380/520	440/580	340/1100
WEEK 12	200/320	370/700	630/620	480/660
	210/600	340/780	510/550	-
	280/370	-	-	360/560
	300/520	510/540	530/1000	460/620
	280/280	460/650	490/750	500/900

TABLE 7. SUBGROUP MEANS, RATIO OF EPITHELIUM (SB-CCT) TO CONNECTIVE TISSUE (CCT-AB), UNOPERATED LEFT SIDE

(*= greater than 1 Std. Dev. above the overall mean
#= greater than 1 Std. Dev. below the overall mean)

	GROUP B CONTROL RM. AIR	GROUP C 20.8% O2 2.4 ATM.	GROUP D 100% O2 1 ATMOS.	GROUP E 100% O2 2.4 ATM.
DAY 1	0.50382 ±0.1166	0.99526* ±0.5221	0.65278 ±0.0852	0.61016 ±0.2402
DAY 2	0.50625 ±0.0888	0.59570 ±0.0992	0.67097 ±0.1685	0.69474 ±0.1691
DAY 3	0.19023# ±0.1261	0.46285 ±0.1180	0.55567 ±0.2967	0.70050 ±0.1950
WEEK 1	0.73214 ±0.2342	0.66875 ±0.1604	0.67796 ±0.1413	0.51442 ±0.0767
WEEK 2	0.57332 ±0.1191	0.75281 ±0.2541	0.96434* ±0.5637	0.51588 ±0.1654
WEEK 3	0.54067 ±0.3040	0.56162 ±0.2943	0.55040 ±0.2521	0.50729 ±0.1314
WEEK 6	0.62048 ±0.2311	0.59914 ±0.1465	0.70499 ±0.3063	0.57912 ±0.2133
WEEK 12	0.66174 ±0.2394	0.65415 ±0.2240	0.78168 ±0.2280	0.66691 ±0.0861

TABLE 8. COMPARISON OF SUBGROUP MEANS, RATIO OF EPITHELIUM TO TOTAL CONNECTIVE TISSUE, OPERATED AND UNOPERATED SIDES

(Epithelium, SB-CCT, divided by Connective Tissue, CCT-AB R= right side, operated; L= left side, unoperated)

	GROUP B CONTROL RM. AIR	GROUP C 20.8% O2 2.4 ATM.	GROUP D 100% O2 1 ATMOS.	GROUP E 100% O2 2.4 ATM.
WEEK 1	R 0.8225	R 0.5420	R 0.4280	R 0.3725
	L 0.7321	L 0.6688	L 0.6780	L 0.5144
WEEK 2	R 0.6850	R 0.8700	R 0.4375	R 0.3700
	L 0.5733	L 0.7528	L 0.9634	L 0.5159
WEEK 3	R 0.6450	R 0.5960	R 0.4200	R 0.5040
	L 0.5407	L 0.5616	L 0.5504	L 0.5073
WEEK 6	R 0.9020	R 0.7760	R 0.6475	R 0.5600
	L 0.6205	L 0.5991	L 0.7050	L 0.5791
WEEK 12	R 0.6962	R 0.4460	R 0.7320	R 0.4460
	L 0.6617	L 0.6542	L 0.7817	L 0.6669

interpreted with regard to the increasing distance to alveolar bone on the operated side over the twelve week period (Table 5).

IV. DISCUSSION

The null hypothesis that there would be no difference between the control and oxygen enhanced groups cannot be accepted. Both qualitative observations and histometric quantitative data indicate that wound healing was enhanced by oxygen therapy although the degree of enhancement decreased in statistical significance when oberved over a three month period. By one week, the greater maturation of the wound healing process was more noticeable in the oxygen groups as compared to the controls. The normobaric Group D exhibited early enhancement for the first two weeks of healing but then failed to be statistically significant at later times, although a residual enhancement of connective tissue healing above the base of the notch remained. At three and six weeks, the hyperbaric Groups C and E maintained a significantly greater connective tissue adaptation as compared to control Group B. Although there was no statistical difference among the four groups at twelve weeks, there was still more connective tissue adjacent to the tooth above the notch. Total connective tissue above bone was also greater for the hyperbaric groups at twelve weeks. The trend for all groups was to develop a long junctional epithelial attachment, although this was delayed in the groups that received postoperative oxygen therapy.

Thus, hyperoxic conditions initially influenced the ratio of connective tissue and epithelial healing. While this effect is most evident in the hyperbaric oxygen Groups C and E, it is also present in the normobaric 100% oxygen Group D. Group D at two weeks exhibited 46% connective tissue adaptation, the greatest amount seen during the study. This may indicate early enhancement by 100% oxygen at 1 atmosphere. These findings are in agreement with previous studies (Marx 1982, 1983). Marx (unpublished) also found normobaric 100% oxygen to be effective in enhancing skin wound healing in rabbits. Korn et al. (1977) observed improvement in burn wound healing in a hyperbaric 10% oxygen group over that of room air controls.

With regard to tooth surface changes in the present investigation, new cementum formation was only occasionally observed. Connective tissue fibers were not functionally oriented, perpendicular, or inserted into cementum. Without this anchorage for connective tissue attachment, junctional epithelium progressed apically, terminated occasionally by areas of root resorption (Plates 10a and 10b). Also the epithelial migration tended to stop at the top of the instrumentation notches, many of which exhibited resorption. The epithelium rarely entered the notches and the connective tissue measured from the base of the defect often represented only that found within the width of the

PLATE 10a. EXAMPLE OF ROOT RESORPTION AND APICAL EXTENT OF EPITHELIUM (GROUP C ANIMAL AT 3 WEEKS X 100)

(Apical progression of epithelium is halted by connective tissue in resorptive bay, coronal to the notch left by instrumentation)

PLATE 10b. EXAMPLE OF ROOT RESORPTION AND APICAL EXTENT OF EPITHELIUM (GROUP E ANIMAL AT 3 WEEKS X 200) notch. The slight increase in proportion of connective tissue above the base of the notch in the controls at 12 weeks (16%) might be attributable to the greater vertical height of the notch itself due to resorptive remodeling. The measured connective tissue within the notch or resorptive bay would account for this 16 percent.

The role of root resorption has recently been discussed with regard to the type of connective tissue that may promote it (Klinge et al., 1985, Nyman et al., 1985, Stahl and Tarnow, 1985). The proximity of gingival connective tissue cells to the root has been more strongly associated with root resorption than the proximity of periodontal ligament connective tissue cells. Such root resorption may be prevented by the presence of epithelium, i.e. junctional epithelium, between the root and gingival connective tissue. Houston et al., 1985, studied submerged, root planed roots and found root resorption or connective tissue adhesion in the coronal half of the roots while new cementum and attachment occurred in the portions nearest intact periodontal ligament. In the present study, one could speculate that in cases of coronal root resorption, gingival versus periodontal ligament connective tissue proliferation was responsible. This would explain the lack of enduring attachment, since this type of healing is attributable to periodontal ligament cells by Nyman and others (1982a, 1982b). However at this time, distinct resorptive differences between gingival and periodontal ligament cells have not been demonstrated.

Limitations of this study are the same as any cross-sectional sacrifice study in that it implies that each succeeding time period represents the effect that would have occurred longitudinally if the previous animals had not been sacrificed. Also the limitations of histometric measurement of a three dimensional biologic system are apparent. One cannot clinically examine the nature of the tissue adaptation on a two dimensional histologic section. Although, in this study several serial sections were examined before two representative slides were measured and then averaged to account for arithmetic differences. A longer period of observation, six months to one year, would help to confirm the findings of this investigation.

Also the role of oral hygiene must be considered. In the present model no hygiene measures were performed postoperatively. The wedge-shaped wounds of this study may have prevented readaptation of the tissue against the root, allowing early plaque contamination to occur. This may have interfered with reattachment to residual cemental fibers or newly exposed dentinal fibers. If oral hygiene were accomplished in a larger model, early connective tissue enhancement may have been sustained and apical epithelial progression deterred.

Finally, one cannot be sure of the mechanism of the observed effect promoted by hyperoxic therapy in this study. The presumed mechanism is based upon enhanced connective tissue proliferation due to greater fibroblast collagen production (Hunt et al., 1977). However, healing may be initially enhanced by an antimicrobial effect promoted by the oxygen therapy rather than by greater fibroblast activity. The effect of oxygen on crevicular organisms may be such that anaerobic species are suppressed during healing and the flora altered to produce less inflammation. Several authors have proposed effects of altered oxygen environment on the microbial flora (Listgarten, 1976, Gottlieb, 1977, Brown et al., 1979, Lindhe, 1983, Mettraux et al., 1984).

Furthermore there may be immunologic changes as a result of the hyperoxygenation, especially oxygen dependent cytotoxic mechanisms of polymorphonuclear leukocytes. This effect has also been studied (Hohn, 1977, Borregaard and Kragballe, 1982, Klebanoff, 1982). The refractory periodontal patient or one with neutrophil defects may benefit from hyperbaric oxygen's ability to enhance host response, as seen in the treatment of diabetic leg ulcerations. Dependence on oxygen at the cellular level may account for many changes that cannot be explained with present technology, although it was not the purpose of this investigation to address the validity of these mechanisms.

In conclusion, the effect of hyperoxic therpy observed in the present investigation was mostly transient except in limited areas where actual attachment of the proliferating connective tissue to the root occurred. The early presence of connective tissue above the reference notch was not indicative of true attachment as a thin epithelial layer intervened between the tooth and connective tissue by twelve weeks. This is in contradiction to Listgarten (Listgarten et al., 1982) who observed epithelial replacement by connective tissue over a twelve month period. In the current study, apical progression of epithelium was observed over a three month period. In some instances this progression was associated with inflammation, as in the case of hair impaction within the gingival crevice. However the apical displacement of connective tissue may represent the tenuous nature of the early connective tissue adaption, allowing progressive apical epithelial migration where fibrous attachment failed to occur.

V. SUMMARY

As a research tool, hyperbaric oxygen at 2.4 atmospheres and either 20% or 100% oxygen concentration may be useful in enhancing the initial proliferation of gingival connective tissue during wound healing. A lesser enhancement is also seen with 100% normobaric oxygen within the constraints of this study. However, early connective tissue adaptation does not necessarily infer eventual connective tissue attachment, as a gradual apical epithelial downgrowth occurred by 12 weeks.

APPENDIX

RAW DATA OF HISTOMETRIC MEASUREMENTS

KEY:

(measurements in increments of 20 micron eyepiece markings)

GM-SB, gingival margin to sulcus base*

SB-CCT, sulcus base to most coronal connective tissue*

CCT-AB, most coronal connective tissue to alveolar bone*

BD-GM, base of defect to gingival margin*

BD-SB, base of defect to sulcus base*

BD-CEJ, base of defect to cemento-enamel junction

BD-CCT, base of defect to most coronal connective tissue

BD-AB, base of defect to alveolar bone

(*unable to measure for early wounds)

GROUP A= IMMEDIATE SACRIFICE

GROUP B= 20% OXYGEN, 1 ATMOSPHERE

GROUP C= 20% OXYGEN, 2.4 ATMOSPHERES

GROUP D= 100% OXYGEN, 1 ATMOSPHERE

GROUP E= 100% OXYGEN, 2.4 ATMOSPHERES

GROUP A DAY 0

Animal 1	Right Side Slide 1	Right Side Slide 2	Right Side Average	Left Side Slide 1	Left Side Slide 2	Left Side Average
GM-SB	-	-	-	10	11	10.5
SB-CCT	-	-	-	20	22	21
CCT-AB	-	-	-	36	33	34.5
BD-GM	-	-	-			
BD-SB	-	-	-			
BD-CEJ	26	30	28			
BD-CCT	0	0	0			
BD-AB	6	6	6			

Animal 2	Right Side Slide 1	Right Side Slide 2	Right Side Average	Left Side Slide 1	Left Side Slide 2	Left Side Average
GM-SB	-	-	-	5	4	4.5
SB-CCT	-	-	-	17	20	18.5
CCT-AB	-	-	-	26	28	27
BD-GM	-	-	-			
BD-SB	-	-	-			
BD-CEJ	60	62	61			
BD-CCT	0	0	0			
BD-AB	6	6	6			

Animal 3	Right Side Slide 1	Right Side Slide 2	Right Side Average	Left Side Slide 1	Left Side Slide 2	Left Side Average
GM-SB	-	-	-	10	4	7
SB-CCT	-	-	-	18	27	22.5
CCT-AB	-	-	-	43	42	42.5
BD-GM	-	-	-			
BD-SB	-	-	-			
BD-CEJ	51	55	53			
BD-CCT	0	0	0			
BD-AB	9	10	9.5			

Animal 4	Right Side Slide 1	Right Side Slide 2	Right Side Average	Left Side Slide 1	Left Side Slide 2	Left Side Average
GM-SB	-	-	-	4	6	5
SB-CCT	-	-	-	20	15	17.5
CCT-AB	-	-	-	31	33	32
BD-GM	-	-	-			
BD-SB	-	-	-			
BD-CEJ	37	38	37.5			
BD-CCT	0	0	0			
BD-AB	5	5	5			

Animal 5	Right Side Slide 1	Right Side Slide 2	Right Side Average	Left Side Slide 1	Left Side Slide 2	Left Side Average
GM-SB	-	-	-	8	12	10
SB-CCT	-	-	-	15	15	15
CCT-AB	-	-	-	27	29	28
BD-GM	-	-	-			
BD-SB	-	-	-			
BD-CEJ	43	52	47.5			
BD-CCT	0	0	0			
BD-AB	6	5	5.5			

GM = Gingival Margin
SB = Sulcus Base
CCT = Most Coronal Connective Tissue
AB = Alveolar Bone
BD = Base of Defect
CEJ = Cemento-Enamel Junction
Units = 20 microns

GROUP B DAY 1

Animal 1	Right Slide 1	Right Slide 2	Right Average	Left Slide 1	Left Slide 2	Left Average
GM-SB	-	-	-	10	13	11.5
SB-CCT	-	-	-	18	14	16
CCT-AB	-	-	-	30	29	29.5
BD-GM	-	-	-			
BD-SB	-	-	-			
BD-CEJ	35	34	34.5			
BD-CCT	0	0	0			
BD-AB	13	10	11.5			

Animal 2	Right Slide 1	Right Slide 2	Right Average	Left Slide 1	Left Slide 2	Left Average
GM-SB	-	-	-	9	9	9
SB-CCT	-	-	-	18	16	17
CCT-AB	-	-	-	23	30	26.5
BD-GM	-	-	-			
BD-SB	-	-	-			
BD-CEJ	41	41	41			
BD-CCT	0	0	0			
BD-AB	3	3	3			

Animal 3	Right Slide 1	Right Slide 2	Right Average	Left Slide 1	Left Slide 2	Left Average
GM-SB	-	-	-	10	11	10.5
SB-CCT	-	-	-	12	10	11
CCT-AB	-	-	-	30	35	32.5
BD-GM	-	-	-			
BD-SB	-	-	-			
BD-CEJ	28	34	31			
BD-CCT	0	0	0			
BD-AB	10	9	9.5			

Animal 4	Right Slide 1	Right Slide 2	Right Average	Left Slide 1	Left Slide 2	Left Average
GM-SB	-	-	-	10	10	10
SB-CCT	-	-	-	14	16	15
CCT-AB	-	-	-	28	26	27
BD-GM	-	-	-			
BD-SB	-	-	-			
BD-CEJ	47	40	43.5			
BD-CCT	0	0	0			
BD-AB	5	10	7.5			

Animal 5	Right Slide 1	Right Slide 2	Right Average	Left Slide 1	Left Slide 2	Left Average
GM-SB	-	-	-	9	12	10.5
SB-CCT	-	-	-	15	15	15
CCT-AB	-	-	-	32	36	34
BD-GM	-	-	-			
BD-SB	-	-	-			
BD-CEJ	39	41	40			
BD-CCT	0	0	0			
BD-AB	15	10	12.5			

GM = Gingival Margin
SB = Sulcus Base
CCT = Most Coronal Connective Tissue
AB = Alveolar Bone
BD = Base of Defect
CEJ = Cemento-Enamel Junction
Units = 20 microns

GROUP B DAY 2

Animal 1	Right Side Slide 1	Right Side Slide 2	Right Side Average	Left Side Slide 1	Left Side Slide 2	Left Side Average
GM-SB	-	-	-	7	8	7.5
SB-CCT	-	-	-	17	16	16.5
CCT-AB	-	-	-	32	37	34.5
BD-GM	-	-	-			
BD-SB	-	-	-			
BD-CEJ	40	39	39.5			
BD-CCT	0	0	0			
BD-AB	9	9	9			

Animal 2	Right Side Slide 1	Right Side Slide 2	Right Side Average	Left Side Slide 1	Left Side Slide 2	Left Side Average
GM-SB	-	-	-	7	7	7
SB-CCT	-	-	-	20	17	18.5
CCT-AB	-	-	-	31	33	32
BD-GM	-	-	-			
BD-SB	-	-	-			
BD-CEJ	40	37	38.5			
BD-CCT	0	0	0			
BD-AB	8	6	7			

Animal 3	Right Side Slide 1	Right Side Slide 2	Right Side Average	Left Side Slide 1	Left Side Slide 2	Left Side Average
GM-SB	-	-	-	11	13	12
SB-CCT	-	-	-	21	21	21
CCT-AB	-	-	-	33	38	35.5
BD-GM	-	-	-			
BD-SB	-	-	-			
BD-CEJ	41	41	41			
BD-CCT	0	0	0			
BD-AB	4	5	4.5			

Animal 4	Right Side Slide 1	Right Side Slide 2	Right Side Average	Left Side Slide 1	Left Side Slide 2	Left Side Average
GM-SB	-	-	-	7	7	7
SB-CCT	-	-	-	21	21	21
CCT-AB	-	-	-	40	42	42
BD-GM	-	-	-			
BD-SB	-	-	-			
BD-CEJ	44	46	45			
BD-CCT	0	0	0			
BD-AB	6	4	5			

Animal 5	Right Side Slide 1	Right Side Slide 2	Right Side Average	Left Side Slide 1	Left Side Slide 2	Left Side Average
GM-SB	-	-	-	7	6	6.5
SB-CCT	-	-	-	17	19	18
CCT-AB	-	-	-	32	36	34
BD-GM	-	-	-			
BD-SB	-	-	-			
BD-CEJ	43	44	43.5			
BD-CCT	0	0	0			
BD-AB	13	11	12			

GM = Gingival Margin
SB = Sulcus Base
CCT = Most Coronal Connective Tissue
AB = Alveolar Bone
BD = Base of Defect
CEJ = Cemento-Enamel Junction
Units = 20 microns

GROUP B DAY 3

Animal 1	Right Side Slide 1	Right Side Slide 2	Right Side Average	Left Side Slide 1	Left Side Slide 2	Left Side Average
GM-SB	-	-	-	10	10	10
SB-CCT	-	-	-	23	23	23
CCT-AB	-	-	-	57	57	57
BD-GM	-	-	-			
BD-SB	-	-	-			
BD-CEJ	50	50	50			
BD-CCT	0	0	0			
BD-AB	6	6	6			

Animal 2	Right Side Slide 1	Right Side Slide 2	Right Side Average	Left Side Slide 1	Left Side Slide 2	Left Side Average
GM-SB	-	-	-	15	10	12.5
SB-CCT	-	-	-	6	6	6
CCT-AB	-	-	-	50	52	51
BD-GM	-	-	-			
BD-SB	-	-	-			
BD-CEJ	49	50	49.5			
BD-CCT	0	0	0			
BD-AB	10	10	10			

Animal 3	Right Side Slide 1	Right Side Slide 2	Right Side Average	Left Side Slide 1	Left Side Slide 2	Left Side Average
GM-SB	-	-	-	9	8	8.5
SB-CCT	-	-	-	10	8	9
CCT-AB	-	-	-	45	42	43.5
BD-GM	-	-	-			
BD-SB	-	-	-			
BD-CEJ	-	-	-			
BD-CCT	-	-	-			
BD-AB	-	-	-			

Animal 4	Right Side Slide 1	Right Side Slide 2	Right Side Average	Left Side Slide 1	Left Side Slide 2	Left Side Average
GM-SB	-	-	-	10	8	9
SB-CCT	-	-	-	7	5	6
CCT-AB	-	-	-	51	49	50
BD-GM	-	-	-			
BD-SB	-	-	-			
BD-CEJ	43	41	42			
BD-CCT	0	0	0			
BD-AB	13	17	15			

Animal 5	Right Side Slide 1	Right Side Slide 2	Right Side Average	Left Side Slide 1	Left Side Slide 2	Left Side Average
GM-SB	-	-	-	11	8	9.5
SB-CCT	-	-	-	5	5	5
CCT-AB	-	-	-	48	49	48.5
BD-GM	-	-	-			
BD-SB	-	-	-			
BD-CEJ	47	45	46			
BD-CCT	0	0	0			
BD-AB	14	16	15			

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SB = Sulcus Base
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Units = 20 microns

GROUP B WEEK 1

Animal 1	Right Side Slide 1	Right Side Slide 2	Right Side Average	Left Side Slide 1	Left Side Slide 2	Left Side Average
GM-SB	-	-	-	9	11	10
SB-CCT	-	-	-	15	15	15
CCT-AB	-	-	-	20	20	20
BD-GM	-	-	-			
BD-SB	-	-	-			
BD-CEJ	-	-	-			
BD-CCT	-	-	-			
BD-AB	-	-	-			

Animal 2	Right Side Slide 1	Right Side Slide 2	Right Side Average	Left Side Slide 1	Left Side Slide 2	Left Side Average
GM-SB	7	8	7.5	-	-	-
SB-CCT	9	7	8	-	-	-
CCT-AB	13	16	14.5	-	-	-
BD-GM	15	15	15			
BD-SB	9	8	8.5			
BD-CEJ	21	26	23.5			
BD-CCT	0	0	0			
BD-AB	10	13	11.5			

Animal 3	Right Side Slide 1	Right Side Slide 2	Right Side Average	Left Side Slide 1	Left Side Slide 2	Left Side Average
GM-SB	6	6	6	10	5	7.5
SB-CCT	15	15	15	20	10	15
CCT-AB	15	15	15	30	40	45
BD-GM	21	21	21			
BD-SB	15	15	15			
BD-CEJ	20	20	20			
BD-CCT	0	0	0			
BD-AB	15	12	13.5			

Animal 4	Right Side Slide 1	Right Side Slide 2	Right Side Average	Left Side Slide 1	Left Side Slide 2	Left Side Average
GM-SB	5	3	4	10	10	10
SB-CCT	10	10	10	15	15	15
CCT-AB	17	12	14.5	20	20	20
BD-GM	15	18	16.5			
BD-SB	10	13	11.5			
BD-CEJ	22	22	22			
BD-CCT	0	3	1.5			
BD-AB	17	16	16.5			

Animal 5	Right Side Slide 1	Right Side Slide 2	Right Side Average	Left Side Slide 1	Left Side Slide 2	Left Side Average
GM-SB	7	6	6.5	10	10	10
SB-CCT	12	11	11.5	22	25	23.5
CCT-AB	11	11	11	28	25	23.5
BD-GM	17	16	16.5			
BD-SB	11	11	11			
BD-CEJ	21	21	21			
BD-CCT	0	0	0			
BD-AB	11	11	11			

GM = Gingival Margin
SB = Sulcus Base
CCT = Most Coronal Connective Tissue
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BD = Base of Defect
CEJ = Cemento-Enamel Junction
Units = 20 microns

GROUP B WEEK 2

Animal 1	Right Slide 1	Right Slide 2	Right Average	Left Slide 1	Left Slide 2	Left Average
GM-SB	0	0	0	10	10	10
SB-CCT	12	15	13.5	20	20	20
CCT-AB	25	25	25	32	30	31
BD-GM	18	15	16.5			
BD-SB	18	15	16.5			
BD-CEJ	25	20	22.5			
BD-CCT	0	0	0			
BD-AB	24	24	24			

Animal 2	Right Slide 1	Right Slide 2	Right Average	Left Slide 1	Left Slide 2	Left Average
GM-SB	5	8	6.5	3	6	4.5
SB-CCT	25	24	24.5	12	11	11.5
CCT-AB	20	20	20	27	26	26.5
BD-GM	30	34	32			
BD-SB	25	25	25			
BD-CEJ	30	30	30			
BD-CCT	1	1	1			
BD-AB	20	20	20			

Animal 3	Right Slide 1	Right Slide 2	Right Average	Left Slide 1	Left Slide 2	Left Average
GM-SB	0	0	0	5	4	4.5
SB-CCT	12	13	12.5	14	18	16
CCT-AB	34	36	35	24	22	23
BD-GM	20	24	22			
BD-SB	20	24	22			
BD-CEJ	34	24	29			
BD-CCT	7	10	8.5			
BD-AB	27	27	27			

Animal 4	Right Slide 1	Right Slide 2	Right Average	Left Slide 1	Left Slide 2	Left Average
GM-SB	7	5	6	3	5	4
SB-CCT	12	15	13.5	14	14	14
CCT-AB	21	20	20.5	27	27	27
BD-GM	22	23	22.5			
BD-SB	16	17	16.5			
BD-CEJ	25	25	25			
BD-CCT	3	3	3			
BD-AB	18	17	17.5			

Animal 5	Right Slide 1	Right Slide 2	Right Average	Left Slide 1	Left Slide 2	Left Average
GM-SB	3	3	3	-	-	-
SB-CCT	24	15	19.5	-	-	-
CCT-AB	27	34	30.5	-	-	-
BD-GM	24	23	23.5			
BD-SB	24	20	22			
BD-CEJ	24	10	17			
BD-CCT	0	6	3			
BD-AB	25	27	26			

GM = Gingival Margin
SB = Sulcus Base
CCT = Most Coronal Connective Tissue
AB = Alveolar Bone
BD = Base of Defect
CEJ = Cemento-Enamel Junction
Units = 20 microns

GROUP B WEEK 3

Animal 1	Right Side Slide 1	Right Side Slide 2	Right Side Average	Left Side Slide 1	Left Side Slide 2	Left Side Average
GM-SB	3	3	3	11	12	11.5
SB-CCT	20	22	21	13	12	12.5
CCT-AB	25	25	25	22	21	21.5
BD-GM	25	30	27.5			
BD-SB	21	21	21			
BD-CEJ	25	25	25			
BD-CCT	1	1	1			
BD-AB	20	20	20			

Animal 2	Right Side Slide 1	Right Side Slide 2	Right Side Average	Left Side Slide 1	Left Side Slide 2	Left Side Average
GM-SB	-	-	-	8	6	7
SB-CCT	-	-	-	17	15	16
CCT-AB	-	-	-	16	18	17
BD-GM	-	-	-			
BD-SB	-	-	-			
BD-CEJ	-	-	-			
BD-CCT	-	-	-			
BD-AB	-	-	-			

Animal 3	Right Side Slide 1	Right Side Slide 2	Right Side Average	Left Side Slide 1	Left Side Slide 2	Left Side Average
GM-SB	5	5	5	-	-	-
SB-CCT	12	13	12.5	-	-	-
CCT-AB	27	30	28.5	-	-	-
BD-GM	20	21	20.5			
BD-SB	15	16	15.5			
BD-CEJ	24	23	23.5			
BD-CCT	3	2	2.5			
BD-AB	25	27	26			

Animal 4	Right Side Slide 1	Right Side Slide 2	Right Side Average	Left Side Slide 1	Left Side Slide 2	Left Side Average
GM-SB	5	5	5	10	10	10
SB-CCT	12	13	12.5	7	7	7
CCT-AB	22	19	20.5	31	31	31
BD-GM	20	20	20			
BD-SB	16	16	16			
BD-CEJ	25	25	25			
BD-CCT	2	2	2			
BD-AB	17	17	17			

Animal 5	Right Side Slide 1	Right Side Slide 2	Right Side Average	Left Side Slide 1	Left Side Slide 2	Left Side Average
GM-SB	5	7	6	6	5	5.5
SB-CCT	20	20	20	13	16	14.5
CCT-AB	28	30	29	37	33	35
BD-GM	30	32	31			
BD-SB	25	20	22.5			
BD-CEJ	30	26	28			
BD-CCT	5	4	4.5			
BD-AB	26	25	25.5			

GM = Gingival Margin
SB = Sulcus Base
CCT = Most Coronal Connective Tissue
AB = Alveolar Bone
BD = Base of Defect
CEJ = Cemento-Enamel Junction
Units = 20 microns

GROUP B WEEK 6

Animal 1	Right Side Slide 1	Right Side Slide 2	Right Side Average	Left Side Slide 1	Left Side Slide 2	Left Side Average
GM-SB	3	5	4	14	14	14
SB-CCT	25	23	24	10	10	10
CCT-AB	30	25	27.5	20	20	20
BD-GM	33	30	31.5			
BD-SB	30	25	27.5			
BD-CEJ	30	25	27.5			
BD-CCT	4	3	3.5			
BD-AB	24	22	23			

Animal 2	Right Side Slide 1	Right Side Slide 2	Right Side Average	Left Side Slide 1	Left Side Slide 2	Left Side Average
GM-SB	8	7	7.5	10	10	10
SB-CCT	15	14	14.5	19	15	17
CCT-AB	17	18	17.5	20	20	20
BD-GM	25	20	22.5			
BD-SB	15	16	15.5			
BD-CEJ	25	25	25			
BD-CCT	0	0	0			
BD-AB	16	18	17			

Animal 3	Right Side Slide 1	Right Side Slide 2	Right Side Average	Left Side Slide 1	Left Side Slide 2	Left Side Average
GM-SB	9	5	7	5	5	5
SB-CCT	20	25	22.5	10	10	10
CCT-AB	23	20	21.5	35	35	35
BD-GM	31	31	31			
BD-SB	23	26	24.5			
BD-CEJ	23	25	24			
BD-CCT	2	2	2			
BD-AB	23	18	19.5			

Animal 4	Right Side Slide 1	Right Side Slide 2	Right Side Average	Left Side Slide 1	Left Side Slide 2	Left Side Average
GM-SB	5	6	5.5	10	10	10
SB-CCT	25	24	24.5	7	7	7
CCT-AB	24	24	24	21	21	21
BD-GM	34	35	34.5			
BD-SB	26	28	27			
BD-CEJ	26	28	27			
BD-CCT	3	4	3.5			
BD-AB	21	20	20.5			

Animal 5	Right Side Slide 1	Right Side Slide 2	Right Side Average	Left Side Slide 1	Left Side Slide 2	Left Side Average
GM-SB	9	9	9	-	-	-
SB-CCT	20	20	20	-	-	-
CCT-AB	27	27	27	-	-	-
BD-GM	27	27	27			
BD-SB	20	20	20			
BD-CEJ	27	27	27			
BD-CCT	0	0	0			
BD-AB	27	27	27			

GM = Gingival Margin
SB = Sulcus Base
CCT = Most Coronal Connective Tissue
AB = Alveolar Bone
BD = Base of Defect
CEJ = Cemento-Enamel Junction
Units = 20 microns

GROUP B WEEK 12

Animal 1	Right Slide 1	Right Slide 2	Right Average	Left Slide 1	Left Slide 2	Left Average
GM-SB	-	-	-	11	11	11
SB-CCT	-	-	-	10	10	10
CCT-AB	-	-	-	16	16	16
BD-GM	-	-	-			
BD-SB	-	-	-			
BD-CEJ	-	-	-			
BD-CCT	-	-	-			
BD-AB	-	-	-			

Animal 2	Right Slide 1	Right Slide 2	Right Average	Left Slide 1	Left Slide 2	Left Average
GM-SB	7	7	7	9	10	9.5
SB-CCT	22	22	22	11	10	10.5
CCT-AB	20	20	20	20	20	20
BD-GM	30	30	30			
BD-SB	22	22	22			
BD-CEJ	27	27	27			
BD-CCT	0	0	0			
BD-AB	20	20	20			

Animal 3	Right Slide 1	Right Slide 2	Right Average	Left Slide 1	Left Slide 2	Left Average
GM-SB	10	7	8.5	13	10	11.5
SB-CCT	16	17	16.5	13	15	14
CCT-AB	32	30	31	17	20	18.5
BD-GM	33	26	29.5			
BD-SB	22	18	20			
BD-CEJ	35	30	32.5			
BD-CCT	5	0	2.5			
BD-AB	27	30	28.5			

Animal 4	Right Slide 1	Right Slide 2	Right Average	Left Slide 1	Left Slide 2	Left Average
GM-SB	15	14	14.5	10	10	10
SB-CCT	20	21	20.5	15	15	15
CCT-AB	48	48	48	26	26	26
BD-GM	48	45	46.5			
BD-SB	32	33	32.5			
BD-CEJ	48	47	47.5			
BD-CCT	10	13	11.5			
BD-AB	35	36	35.5			

Animal 5	Right Slide 1	Right Slide 2	Right Average	Left Slide 1	Left Slide 2	Left Average
GM-SB	10	12	11	10	7	8.5
SB-CCT	28	30	29	13	15	14
CCT-AB	40	40	40	13	15	14
BD-GM	53	50	51.5			
BD-SB	43	40	41.5			
BD-CEJ	57	57	57			
BD-CCT	7	7	7			
BD-AB	30	34	32			

GM = Gingival Margin
SB = Sulcus Base
CCT = Most Coronal Connective Tissue
AB = Alveolar Bone

BD = Base of Defect
CEJ = Cemento-Enamel Junction
Units = 20 microns

GROUP C DAY 1

Animal 1	Right Side Slide 1	Right Side Slide 2	Right Side Average	Left Side Slide 1	Left Side Slide 2	Left Side Average
GM-SB	-	-	-	12	11	11.5
SB-CCT	-	-	-	18	19	18.5
CCT-AB	-	-	-	22	23	22.5
BD-GM	-	-	-			
BD-SB	-	-	-			
BD-CEJ	37	40	38.5			
BD-CCT	2	2	2			
BD-AB	13	12	12.5			

Animal 2	Right Side Slide 1	Right Side Slide 2	Right Side Average	Left Side Slide 1	Left Side Slide 2	Left Side Average
GM-SB	-	-	-	8	7	7.5
SB-CCT	-	-	-	17	17	17
CCT-AB	-	-	-	26	23	24.5
BD-GM	-	-	-			
BD-SB	-	-	-			
BD-CEJ	51	45	48			
BD-CCT	0	0	0			
BD-AB	7	8	7.5			

Animal 3	Right Side Slide 1	Right Side Slide 2	Right Side Average	Left Side Slide 1	Left Side Slide 2	Left Side Average
GM-SB	-	-	-	8	10	9
SB-CCT	-	-	-	19	20	19.5
CCT-AB	-	-	-	33	31	32
BD-GM	-	-	-			
BD-SB	-	-	-			
BD-CEJ	29	25	27			
BD-CCT	2	0	1			
BD-AB	12	11	11.5			

Animal 4	Right Side Slide 1	Right Side Slide 2	Right Side Average	Left Side Slide 1	Left Side Slide 2	Left Side Average
GM-SB	-	-	-	10	9	9.5
SB-CCT	-	-	-	38	38	38
CCT-AB	-	-	-	20	20	20
BD-GM	-	-	-			
BD-SB	-	-	-			
BD-CEJ	43	44	43.5			
BD-CCT	0	0	0			
BD-AB	6	3	4.5			

Animal 5	Right Side Slide 1	Right Side Slide 2	Right Side Average	Left Side Slide 1	Left Side Slide 2	Left Side Average
GM-SB	-	-	-	10	11	10.5
SB-CCT	-	-	-	28	30	29
CCT-AB	-	-	-	31	30	30.5
BD-GM	-	-	-			
BD-SB	-	-	-			
BD-CEJ	50	52	51			
BD-CCT	0	0	0			
BD-AB	5	1	3			

GM = Gingival Margin
SB = Sulcus Base
CCT = Most Coronal Connective Tissue
AB = Alveolar Bone

BD = Base of Defect
CEJ = Cemento-Enamel Junction
Units = 20 microns

GROUP C DAY 2

	RIGHT SIDE			LEFT SIDE		
Animal 1	Slide 1	Slide 2	Average	Slide 1	Slide 2	Average
GM-SB	-	-	-	11	11	11
SB-CCT	-	-	-	15	15	15
CCT-AB	-	-	-	31	30	30.5
BD-GM	-	-	-			
BD-SB	-	-	-			
BD-CEJ	45	44	44.5			
BD-CCT	0	0	0			
BD-AB	5	5	5			
Animal 2	Slide 1	Slide 2	Average	Slide 1	Slide 2	Average
GM-SB	-	-	-	10	8	9
SB-CCT	-	-	-	20	18	19
CCT-AB	-	-	-	34	34	34
BD-GM	-	-	-			
BD-SB	-	-	-			
BD-CEJ	40	39	39.5			
BD-CCT	0	0	0			
BD-AB	9	10	9.5			
Animal 3	Slide 1	Slide 2	Average	Slide 1	Slide 2	Average
GM-SB	-	-	-	10	10	10
SB-CCT	-	-	-	15	19	17
CCT-AB	-	-	-	26	27	26.5
BD-GM	-	-	-			
BD-SB	-	-	-			
BD-CEJ	50	47	48.5			
BD-CCT	0	0	0			
BD-AB	0	0	0			
Animal 4	Slide 1	Slide 2	Average	Slide 1	Slide 2	Average
GM-SB	-	-	-	3	2	1.5
SB-CCT	-	-	-	20	19	19.5
CCT-AB	-	-	-	37	35	36
BD-GM	-	-	-			
BD-SB	-	-	-			
BD-CEJ	54	50	52			
BD-CCT	1	0	0.5			
BD-AB	6	9	7.5			
Animal 5	Slide 1	Slide 2	Average	Slide 1	Slide 2	Average
GM-SB	-	-	-	3	2	1.5
SB-CCT	-	-	-	20	19	19.5
CCT-AB	-	-	-	37	35	36
BD-GM	-	-	-			
BD-SB	-	-	-			
BD-CEJ	35	35	35			
BD-CCT	0	0	0			
BD-AB	6	6	6			

GM = Gingival Margin
SB = Sulcus Base
CCT = Most Coronal Connective Tissue
AB = Alveolar Bone

BD = Base of Defect
CEJ = Cemento-Enamel Junction
Units = 20 microns

GROUP C DAY 3

Animal 1	Right Side Slide 1	Right Side Slide 2	Right Side Average	Left Side Slide 1	Left Side Slide 2	Left Side Average
GM-SB	-	-	-	10	10	10
SB-CCT	-	-	-	18	19	18.5
CCT-AB	-	-	-	39	35	37
BD-GM	-	-	-			
BD-SB	-	-	-			
BD-CEJ	47	51	49			
BD-CCT	0	0	0			
BD-AB	7	4	5.5			

Animal 2	Right Side Slide 1	Right Side Slide 2	Right Side Average	Left Side Slide 1	Left Side Slide 2	Left Side Average
GM-SB	-	-	-	12	9	10.5
SB-CCT	-	-	-	4	17	10.5
CCT-AB	-	-	-	30	21	25.5
BD-GM	-	-	-			
BD-SB	-	-	-			
BD-CEJ	45	45	45			
BD-CCT	8	10	9			
BD-AB	10	10	10			

Animal 3	Right Side Slide 1	Right Side Slide 2	Right Side Average	Left Side Slide 1	Left Side Slide 2	Left Side Average
GM-SB	-	-	-	10	10	10
SB-CCT	-	-	-	14	14	14
CCT-AB	-	-	-	36	31	33.5
BD-GM	-	-	-			
BD-SB	-	-	-			
BD-CEJ	57	62	59.5			
BD-CCT	0	0	0			
BD-AB	5	7	6			

Animal 4	Right Side Slide 1	Right Side Slide 2	Right Side Average	Left Side Slide 1	Left Side Slide 2	Left Side Average
GM-SB	-	-	-	5	10	7.5
SB-CCT	-	-	-	18	26	22
CCT-AB	-	-	-	35	33	34
BD-GM	-	-	-			
BD-SB	-	-	-			
BD-CEJ	43	47	45			
BD-CCT	0	0	0			
BD-AB	12	10	11			

Animal 5	Right Side Slide 1	Right Side Slide 2	Right Side Average	Left Side Slide 1	Left Side Slide 2	Left Side Average
GM-SB	-	-	-	4	7	5.5
SB-CCT	-	-	-	15	12	13.5
CCT-AB	-	-	-	39	41	40
BD-GM	-	-	-			
BD-SB	-	-	-			
BD-CEJ	44	41	42.5			
BD-CCT	1	0	0.5			
BD-AB	10	10	10			

GM = Gingival Margin
SB = Sulcus Base
CCT = Most Coronal Connective Tissue
AB = Alveolar Bone
BD = Base of Defect
CEJ = Cemento-Enamel Junction
Units = 20 microns

GROUP C WEEK 1

	RIGHT SIDE			LEFT SIDE		
Animal 1	**Slide 1**	**Slide 2**	**Average**	**Slide 1**	**Slide 2**	**Average**
GM-SB	2	2	2	5	8	6.5
SB-CCT	7	5	6	22	19	20.5
CCT-AB	29	20	20.5	29	22	25.5
BD-GM	24	25	24.5			
BD-SB	22	23	22.5			
BD-CEJ	41	50	45.5			
BD-CCT	15	17	16			
BD-AB	14	3	8.5			
Animal 2	**Slide 1**	**Slide 2**	**Average**	**Slide 1**	**Slide 2**	**Average**
GM-SB	5	5	5	10	10	10
SB-CCT	10	13	11.5	20	20	20
CCT-AB	39	36	37.5	25	25	25
BD-GM	40	39	39.5			
BD-SB	35	29	32			
BD-CEJ	68	65	66.5			
BD-CCT	25	21	23			
BD-AB	13	17	15			
Animal 3	**Slide 1**	**Slide 2**	**Average**	**Slide 1**	**Slide 2**	**Average**
GM-SB	2	2	2	9	10	9.5
SB-CCT	18	18	18	24	23	23.5
CCT-AB	20	20	20	33	34	33.5
BD-GM	24	23	23.5			
BD-SB	22	21	21.5			
BD-CEJ	43	41	42			
BD-CCT	5	5	5			
BD-AB	15	16	15.5			
Animal 4	**Slide 1**	**Slide 2**	**Average**	**Slide 1**	**Slide 2**	**Average**
GM-SB	1	1	1	8	7	7.5
SB-CCT	40	10	25	14	13	13.5
CCT-AB	17	28	22.5	32	33	32.5
BD-GM	48	18	33			
BD-SB	47	17	32			
BD-CEJ	58	49	53.5			
BD-CCT	5	8	6.5			
BD-AB	21	21	16.5			
Animal 5	**Slide 1**	**Slide 2**	**Average**	**Slide 1**	**Slide 2**	**Average**
GM-SB	1	1	1	10	10	10
SB-CCT	7	6	6.5	19	19	19
CCT-AB	42	42	42	30	31	30.5
BD-GM	35	34	34.5			
BD-SB	35	33	34			
BD-CEJ	48	46	47			
BD-CCT	26	26	26			
BD-AB	16	16	16			

GM = Gingival Margin
SB = Sulcus Base
CCT = Most Coronal Connective Tissue
AB = Alveolar Bone
BD = Base of Defect
CEJ = Cemento-Enamel Junction
Units = 20 microns

GROUP C WEEK 2

Animal 1	Right Side Slide 1	Right Side Slide 2	Right Side Average	Left Side Slide 1	Left Side Slide 2	Left Side Average
GM-SB	5	2	3.5	10	9	9.5
SB-CCT	27	23	25	26	28	27
CCT-AB	36	38	37	42	42	42
BD-GM	42	42	42			
BD-SB	40	40	40			
BD-CEJ	50	45	47.5			
BD-CCT	15	18	16.5			
BD-AB	20	20	20			

Animal 2	Right Side Slide 1	Right Side Slide 2	Right Side Average	Left Side Slide 1	Left Side Slide 2	Left Side Average
GM-SB	1	1	1	10	10	10
SB-CCT	29	20	24.5	27	27	27
CCT-AB	26	36	31	27	27	27
BD-GM	29	30	29.5			
BD-SB	29	30	29.5			
BD-CEJ	41	41	41			
BD-CCT	0	10	5			
BD-AB	26	26	26			

Animal 3	Right Side Slide 1	Right Side Slide 2	Right Side Average	Left Side Slide 1	Left Side Slide 2	Left Side Average
GM-SB	-	-	-	11	10	10.5
SB-CCT	-	-	-	10	10	10
CCT-AB	-	-	-	29	26	27.5
BD-GM	-	-	-			
BD-SB	-	-	-			
BD-CEJ	-	-	-			
BD-CCT	-	-	-			
BD-AB	-	-	-			

Animal 4	Right Side Slide 1	Right Side Slide 2	Right Side Average	Left Side Slide 1	Left Side Slide 2	Left Side Average
GM-SB	4	2	3	12	12	12
SB-CCT	33	38	35.5	29	27	28
CCT-AB	22	20	21	31	35	33
BD-GM	38	40	29			
BD-SB	34	38	36			
BD-CEJ	38	40	39			
BD-CCT	0	0	0			
BD-AB	22	20	21			

Animal 5	Right Side Slide 1	Right Side Slide 2	Right Side Average	Left Side Slide 1	Left Side Slide 2	Left Side Average
GM-SB	5	5	5	5	5	5
SB-CCT	15	20	17.5	20	30	25
CCT-AB	50	58	54	32	23	27.5
BD-GM	42	45	43.5			
BD-SB	38	40	39			
BD-CEJ	43	44	43.5			
BD-CCT	25	17	21			
BD-AB	25	45	35			

GM = Gingival Margin
SB = Sulcus Base
CCT = Most Coronal Connective Tissue
AB = Alveolar Bone
BD = Base of Defect
CEJ = Cemento-Enamel Junction
Units = 20 microns

GROUP C WEEK 3

Animal 1	Right Slide 1	Right Slide 2	Right Average	Left Slide 1	Left Slide 2	Left Average
GM-SB	5	5	5	10	3	6.5
SB-CCT	20	20	20	15	23	19
CCT-AB	53	50	51.5	27	21	24
BD-GM	59	60	59.5			
BD-SB	54	55	54.5			
BD-CEJ	58	60	59.5			
BD-CCT	35	36	35.5			
BD-AB	17	15	16			

Animal 2	Right Slide 1	Right Slide 2	Right Average	Left Slide 1	Left Slide 2	Left Average
GM-SB	10	10	10	9	8	8.5
SB-CCT	22	23	22.5	10	11	10.5
CCT-AB	40	34	37	30	31	30.5
BD-GM	39	33	36			
BD-SB	29	24	26.5			
BD-CEJ	39	37	38			
BD-CCT	7	20	4.5			
BD-AB	31	31	31			

Animal 3	Right Slide 1	Right Slide 2	Right Average	Left Slide 1	Left Slide 2	Left Average
GM-SB	6	5	5.5	6	8	7
SB-CCT	15	15	15	16	15	15.5
CCT-AB	35	35	35	18	19	18.5
BD-GM	29	34	31.5			
BD-SB	24	27	25.5			
BD-CEJ	40	38	39			
BD-CCT	9	15	12			
BD-AB	26	22	24			

Animal 4	Right Slide 1	Right Slide 2	Right Average	Left Slide 1	Left Slide 2	Left Average
GM-SB	10	15	12.5	8	10	9
SB-CCT	5	6	5.5	15	9	12
CCT-AB	35	30	32.5	43	45	44
BD-GM	30	35	32.5			
BD-SB	20	20	20			
BD-CEJ	34	35	34.5			
BD-CCT	15	13	14			
BD-AB	20	18	19			

Animal 5	Right Slide 1	Right Slide 2	Right Average	Left Slide 1	Left Slide 2	Left Average
GM-SB	14	14	45	-	-	-
SB-CCT	29	29	29	-	-	-
CCT-AB	22	20	21	32	23	27.5
BD-GM	42	43	42.5			
BD-SB	28	29	28.5			
BD-CEJ	38	39	38.5			
BD-CCT	0	0	0			
BD-AB	22	19	20.5			

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SB = Sulcus Base
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BD = Base of Defect
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Units = 20 microns

GROUP C WEEK 6

Animal 1	Right Slide 1	Right Slide 2	Right Average	Left Slide 1	Left Slide 2	Left Average
GM-SB	10	10	10	5	6	5.5
SB-CCT	12	12	12	19	19	19
CCT-AB	31	30	30.5	34	36	35
BD-GM	38	36	37			
BD-SB	28	25	26.5			
BD-CEJ	54	52	53			
BD-CCT	15	13	14			
BD-AB	15	17	16			

Animal 2	Right Slide 1	Right Slide 2	Right Average	Left Slide 1	Left Slide 2	Left Average
GM-SB	15	13	14	5	3	4
SB-CCT	38	31	34.5	18	19	18.5
CCT-AB	25	19	22	32	32	32
BD-GM	49	44	46.5			
BD-SB	35	32	33.5			
BD-CEJ	50	46	48			
BD-CCT	0	0	0			
BD-AB	22	17	19.5			

Animal 3	Right Slide 1	Right Slide 2	Right Average	Left Slide 1	Left Slide 2	Left Average
GM-SB	3	4	3.5	11	9	10
SB-CCT	34	40	37	22	26	24
CCT-AB	33	29	31	32	32	32
BD-GM	34	40	37			
BD-SB	34	32	33			
BD-CEJ	34	46	40			
BD-CCT	0	0	0			
BD-AB	33	30	31.5			

Animal 4	Right Slide 1	Right Slide 2	Right Average	Left Slide 1	Left Slide 2	Left Average
GM-SB	10	10	10	6	5	5.5
SB-CCT	30	29	29.5	13	13	13
CCT-AB	53	52	52.5	31	35	33
BD-GM	52	49	50.5			
BD-SB	41	40	40.5			
BD-CEJ	54	54	54			
BD-CCT	24	23	23.5			
BD-AB	29	28	28.5			

Animal 5	Right Slide 1	Right Slide 2	Right Average	Left Slide 1	Left Slide 2	Left Average
GM-SB	14	19	16.5	7	7	7
SB-CCT	7	4	5.5	20	18	19
CCT-AB	32	33	32.5	26	26	26
BD-GM	32	34	33			
BD-SB	19	15	17			
BD-CEJ	35	35	35			
BD-CCT	11	10	10.5			
BD-AB	22	22	22			

GM = Gingival Margin
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BD = Base of Defect
CEJ = Cemento-Enamel Junction
Units = 20 microns

GROUP C WEEK 12

	RIGHT SIDE			LEFT SIDE		
Animal 1	Slide 1	Slide 2	Average	Slide 1	Slide 2	Average
GM-SB	5	5	5	6	5	5.5
SB-CCT	14	19	16.5	20	17	18.5
CCT-AB	26	26	26	30	40	35
BD-GM	29	29	29			
BD-SB	24	25	24.5			
BD-CEJ	28	35	36.5			
BD-CCT	5	5	5			
BD-AB	21	22	21.5			
Animal 2	Slide 1	Slide 2	Average	Slide 1	Slide 2	Average
GM-SB	8	8	8	5	3	4
SB-CCT	15	14	14.5	17	17	17
CCT-AB	32	32	32	39	39	39
BD-GM	30	30	30			
BD-SB	24	23	23.5			
BD-CEJ	37	38	37.5			
BD-CCT	7	8	7.5			
BD-AB	23	24	23.5			
Animal 3	Slide 1	Slide 2	Average	Slide 1	Slide 2	Average
GM-SB	10	8	9	-	-	-
SB-CCT	15	15	15	-	-	-
CCT-AB	46	48	47	-	-	-
BD-GM	53	51	52			
BD-SB	43	41	42			
BD-CEJ	53	51	52			
BD-CCT	27	27	27			
BD-AB	20	22	21			
Animal 4	Slide 1	Slide 2	Average	Slide 1	Slide 2	Average
GM-SB	10	9	9.5	3	2	2.5
SB-CCT	15	17	16	25	26	25.5
CCT-AB	38	38	38	26	28	27
BD-GM	31	33	32			
BD-SB	21	22	21.5			
BD-CEJ	34	33	33.5			
BD-CCT	5	5	5			
BD-AB	33	31	32			
Animal 5	Slide 1	Slide 2	Average	Slide 1	Slide 2	Average
GM-SB	9	9	9	3	5	4
SB-CCT	17	22	19.5	24	22	23
CCT-AB	52	40	46	30	35	32.5
BD-GM	43	44	43.5			
BD-SB	35	35	35			
BD-CEJ	45	45	45			
BD-CCT	19	12	15.5			
BD-AB	33	30	31.5			

GM = Gingival Margin
SB = Sulcus Base
CCT = Most Coronal Connective Tissue
AB = Alveolar Bone
BD = Base of Defect
CEJ = Cemento-Enamel Junction
Units = 20 microns

GROUP D DAY 1

Animal 1	Right Side Slide 1	Right Side Slide 2	Right Side Average	Left Side Slide 1	Left Side Slide 2	Left Side Average
GM-SB	-	-	-	10	9	9.5
SB-CCT	-	-	-	24	25	24.5
CCT-AB	-	-	-	34	34	34
BD-GM	-	-	-			
BD-SB	-	-	-			
BD-CEJ	51	51	51			
BD-CCT	0	0	0			
BD-AB	7	5	6			

Animal 2	Right Side Slide 1	Right Side Slide 2	Right Side Average	Left Side Slide 1	Left Side Slide 2	Left Side Average
GM-SB	-	-	-	16	17	16.5
SB-CCT	-	-	-	24	25	24.5
CCT-AB	-	-	-	35	34	34.5
BD-GM	-	-	-			
BD-SB	-	-	-			
BD-CEJ	51	53	52			
BD-CCT	0	0	0			
BD-AB	5	4	4.5			

Animal 3	Right Side Slide 1	Right Side Slide 2	Right Side Average	Left Side Slide 1	Left Side Slide 2	Left Side Average
GM-SB	-	-	-	-	-	-
SB-CCT	-	-	-	-	-	-
CCT-AB	-	-	-	-	-	-
BD-GM	-	-	-			
BD-SB	-	-	-			
BD-CEJ	35	38	36.5			
BD-CCT	0	0	0			
BD-AB	7	5	6			

Animal 4	Right Side Slide 1	Right Side Slide 2	Right Side Average	Left Side Slide 1	Left Side Slide 2	Left Side Average
GM-SB	-	-	-	6	6	6
SB-CCT	-	-	-	20	20	20
CCT-AB	-	-	-	32	30	31
BD-GM	-	-	-			
BD-SB	-	-	-			
BD-CEJ	40	40	40			
BD-CCT	0	0	0			
BD-AB	10	10	10			

Animal 5	Right Side Slide 1	Right Side Slide 2	Right Side Average	Left Side Slide 1	Left Side Slide 2	Left Side Average
GM-SB	-	-	-	11	10	10.5
SB-CCT	-	-	-	20	18	19
CCT-AB	-	-	-	35	36	35.5
BD-GM	-	-	-			
BD-SB	-	-	-			
BD-CEJ	43	52	47.5			
BD-CCT	0	0	0			
BD-AB	5	5	5			

GM = Gingival Margin
SB = Sulcus Base
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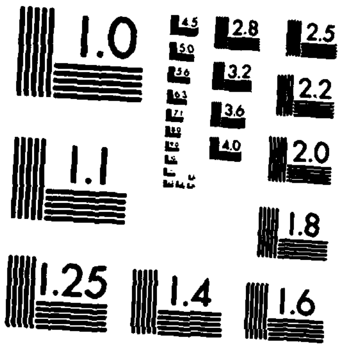
BD = Base of Defect
CEJ = Cemento-Enamel Junction
Units = 20 microns

AD-A172 272 PERIODONTAL WOUND HEALING RESPONSES TO VARYING OXYGEN 2/2
CONCENTRATIONS AND ATMOSPHERIC PRESSURES(U) AIR FORCE
INST OF TECH WRIGHT-PATTERSON AFB OH M D SHANNON
UNCLASSIFIED MAY 86 AFIT/CI/NR-86-165T F/G 6/5 NL



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

GROUP D DAY 2

Animal 1	Right Side Slide 1	Right Side Slide 2	Right Side Average	Left Side Slide 1	Left Side Slide 2	Left Side Average
GM-SB	-	-	-	17	16	16.5
SB-CCT	-	-	-	17	18	17.5
CCT-AB	-	-	-	36	37	36.5
BD-GM	-	-	-			
BD-SB	-	-	-			
BD-CEJ	51	51	51			
BD-CCT	0	0	0			
BD-AB	8	9	8.5			

Animal 2	Right Side Slide 1	Right Side Slide 2	Right Side Average	Left Side Slide 1	Left Side Slide 2	Left Side Average
GM-SB	-	-	-	5	5	5
SB-CCT	-	-	-	24	25	24.5
CCT-AB	-	-	-	28	28	28
BD-GM	-	-	-			
BD-SB	-	-	-			
BD-CEJ	50	50	50			
BD-CCT	0	0	0			
BD-AB	10	10	10			

Animal 3	Right Side Slide 1	Right Side Slide 2	Right Side Average	Left Side Slide 1	Left Side Slide 2	Left Side Average
GM-SB	-	-	-	12	12	12
SB-CCT	-	-	-	28	27	27.5
CCT-AB	-	-	-	40	40	40
BD-GM	-	-	-			
BD-SB	-	-	-			
BD-CEJ	58	57	57.5			
BD-CCT	0	0	0			
BD-AB	5	4	4.5			

Animal 4	Right Side Slide 1	Right Side Slide 2	Right Side Average	Left Side Slide 1	Left Side Slide 2	Left Side Average
GM-SB	-	-	-	8	8	8
SB-CCT	-	-	-	19	23	21
CCT-AB	-	-	-	40	40	40
BD-GM	-	-	-			
BD-SB	-	-	-			
BD-CEJ	45	47	46			
BD-CCT	0	0	0			
BD-AB	7	8	7.5			

Animal 5	Right Side Slide 1	Right Side Slide 2	Right Side Average	Left Side Slide 1	Left Side Slide 2	Left Side Average
GM-SB	-	-	-	12	12	12
SB-CCT	-	-	-	27	25	26
CCT-AB	-	-	-	32	34	33
BD-GM	-	-	-			
BD-SB	-	-	-			
BD-CEJ	50	50	50			
BD-CCT	0	0	0			
BD-AB	7	6	6.5			

GM = Gingival Margin
SB = Sulcus Base
CCT = Most Coronal Connective Tissue
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CEJ = Cemento-Enamel Junction
Units = 20 microns

GROUP D DAY 3

Animal 1	Right Side Slide 1	Right Side Slide 2	Right Side Average	Left Side Slide 1	Left Side Slide 2	Left Side Average
GM-SB	-	-	-	10	10	10.5
SB-CCT	-	-	-	17	15	16
CCT-AB	-	-	-	20	16	18
BD-GM	-	-	-			
BD-SB	-	-	-			
BD-CEJ	30	38	34			
BD-CCT	0	0	0			
BD-AB	8	8	8			

Animal 2	Right Side Slide 1	Right Side Slide 2	Right Side Average	Left Side Slide 1	Left Side Slide 2	Left Side Average
GM-SB	-	-	-	10	10	10
SB-CCT	-	-	-	9	9	9
CCT-AB	-	-	-	50	45	47.5
BD-GM	-	-	-			
BD-SB	-	-	-			
BD-CEJ	55	60	57.5			
BD-CCT	0	0	0			
BD-AB	5	7	6			

Animal 3	Right Side Slide 1	Right Side Slide 2	Right Side Average	Left Side Slide 1	Left Side Slide 2	Left Side Average
GM-SB	-	-	-	10	10	10
SB-CCT	-	-	-	12	12	12
CCT-AB	-	-	-	40	40	40
BD-GM	-	-	-			
BD-SB	-	-	-			
BD-CEJ	25	25	25			
BD-CCT	0	0	0			
BD-AB	36	35	35.5			

Animal 4	Right Side Slide 1	Right Side Slide 2	Right Side Average	Left Side Slide 1	Left Side Slide 2	Left Side Average
GM-SB	-	-	-	10	10	10
SB-CCT	-	-	-	20	22	21
CCT-AB	-	-	-	30	30	30
BD-GM	-	-	-			
BD-SB	-	-	-			
BD-CEJ	-	-	-			
BD-CCT	-	-	-			
BD-AB	-	-	-			

Animal 5	Right Side Slide 1	Right Side Slide 2	Right Side Average	Left Side Slide 1	Left Side Slide 2	Left Side Average
GM-SB	-	-	-	11	10	10.5
SB-CCT	-	-	-	24	25	24.5
CCT-AB	-	-	-	35	35	35
BD-GM	-	-	-			
BD-SB	-	-	-			
BD-CEJ	43	40	41.5			
BD-CCT	9	9	9			
BD-AB	8	8	8			

GM = Gingival Margin
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CCT = Most Coronal Connective Tissue
AB = Alveolar Bone
BD = Base of Defect
CEJ = Cemento-Enamel Junction
Units = 20 microns

GROUP D WEEK 1

Animal 1	Right Side Slide 1	Right Side Slide 2	Right Side Average	Left Side Slide 1	Left Side Slide 2	Left Side Average
GM-SB	5	5	5	12	12	12
SB-CCT	17	20	18.5	20	18	19
CCT-AB	31	27	29	25	25	25
BD-GM	42	40	41			
BD-SB	35	35	35			
BD-CEJ	46	50	48			
BD-CCT	18	16	17			
BD-AB	18	16	17			

Animal 2	Right Side Slide 1	Right Side Slide 2	Right Side Average	Left Side Slide 1	Left Side Slide 2	Left Side Average
GM-SB	5	3	4	20	21	20.5
SB-CCT	13	14	13.5	21	22	21.5
CCT-AB	30	34	32	26	27	26.5
BD-GM	28	25	26.5			
BD-SB	23	22	22.5			
BD-CEJ	48	48	48			
BD-CCT	10	10	10			
BD-AB	24	22	23			

Animal 3	Right Side Slide 1	Right Side Slide 2	Right Side Average	Left Side Slide 1	Left Side Slide 2	Left Side Average
GM-SB	3	3	3	10	7	8.5
SB-CCT	10	8	9	23	20	21.5
CCT-AB	33	34	33.5	30	30	30
BD-GM	25	25	25			
BD-SB	22	22	22			
BD-CEJ	40	40	40			
BD-CCT	13	12	12.5			
BD-AB	22	22	22			

Animal 4	Right Side Slide 1	Right Side Slide 2	Right Side Average	Left Side Slide 1	Left Side Slide 2	Left Side Average
GM-SB	3	2	2.5	19	18	18.5
SB-CCT	7	13	10	28	27	27.5
CCT-AB	23	23	23	42	42	42
BD-GM	20	23	21.5			
BD-SB	17	21	19			
BD-CEJ	50	50	50			
BD-CCT	7	8	7.5			
BD-AB	16	15	15.5			

Animal 5	Right Side Slide 1	Right Side Slide 2	Right Side Average	Left Side Slide 1	Left Side Slide 2	Left Side Average
GM-SB	5	5	5	15	17	16
SB-CCT	8	6	7	9	9	9
CCT-AB	18	19	18.5	43	42	42.5
BD-GM	14	14	14			
BD-SB	9	8	8.5			
BD-CEJ	40	40	40			
BD-CCT	0	0	0			
BD-AB	18	18	18			

GM = Gingival Margin
SB = Sulcus Base
CCT = Most Coronal Connective Tissue
AB = Alveolar Bone
BD = Base of Defect
CEJ = Cemento-Enamel Junction
Units = 20 microns

GROUP D WEEK 2

Animal 1	Right Slide 1	Right Slide 2	Right Average	Left Slide 1	Left Slide 2	Left Average
GM-SB	5	0	2.5	10	10	10
SB-CCT	13	8	10.5	21	21	21
CCT-AB	55	50	52.5	37	35	36
BD-GM	28	19	23.5			
BD-SB	23	19	21			
BD-CEJ	37	38	37.5			
BD-CCT	10	10	10			
BD-AB	45	42	43.5			

Animal 2	Right Slide 1	Right Slide 2	Right Average	Left Slide 1	Left Slide 2	Left Average
GM-SB	2	5	3.5	9	9	9
SB-CCT	23	20	21.5	28	29	28.5
CCT-AB	31	30	30.5	15	15	15
BD-GM	36	35	35.5			
BD-SB	34	30	32			
BD-CEJ	48	48	48			
BD-CCT	11	10	10.5			
BD-AB	20	19	19.5			

Animal 3	Right Slide 1	Right Slide 2	Right Average	Left Slide 1	Left Slide 2	Left Average
GM-SB	3	5	4	11	11	11
SB-CCT	22	21	21.5	19	20	19.5
CCT-AB	52	50	51	40	42	41
BD-GM	55	52	53.5			
BD-SB	52	49	50.5			
BD-CEJ	55	52	53.5			
BD-CCT	30	27	28.5			
BD-AB	20	21	20.5			

Animal 4	Right Slide 1	Right Slide 2	Right Average	Left Slide 1	Left Slide 2	Left Average
GM-SB	-	-	-	9	10	9.5
SB-CCT	-	-	-	22	22	22
CCT-AB	-	-	-	25	26	25.5
BD-GM	-	-	-			
BD-SB	-	-	-			
BD-CEJ	-	-	-			
BD-CCT	-	-	-			
BD-AB	-	-	-			

Animal 5	Right Slide 1	Right Slide 2	Right Average	Left Slide 1	Left Slide 2	Left Average
GM-SB	5	5	5	10	14	12
SB-CCT	22	20	21	30	32	31
CCT-AB	48	49	48.5	32	30	31
BD-GM	47	45	46			
BD-SB	42	40	41			
BD-CEJ	52	50	51			
BD-CCT	20	20	20			
BD-AB	27	28	27.5			

GM = Gingival Margin
SB = Sulcus Base
CCT = Most Coronal Connective Tissue
AB = Alveolar Bone
BD = Base of Defect
CEJ = Cemento-Enamel Junction
Units = 20 microns

GROUP D WEEK 3

	RIGHT SIDE			LEFT SIDE		
Animal 1	Slide 1	Slide 2	Average	Slide 1	Slide 2	Average
GM-SB	3	1	2	-	-	-
SB-CCT	13	13	13	-	-	-
CCT-AB	33	35	34	-	-	-
BD-GM	27	27	27			
BD-SB	25	26	25.5			
BD-CEJ	56	55	55.5			
BD-CCT	12	12	12			
BD-AB	20	20	20			
Animal 2	Slide 1	Slide 2	Average	Slide 1	Slide 2	Average
GM-SB	2	2	2	10	9	9.5
SB-CCT	9	8	8.5	12	11	11.5
CCT-AB	47	47	47	42	42	42
BD-GM	20	16	18			
BD-SB	18	14	16			
BD-CEJ	32	30	31			
BD-CCT	9	5	7			
BD-AB	38	42	40			
Animal 3	Slide 1	Slide 2	Average	Slide 1	Slide 2	Average
GM-SB	15	10	12.5	5	5	5
SB-CCT	6	10	8	24	25	24.5
CCT-AB	40	40	40	32	31	31.5
BD-GM	35	34	34.5			
BD-SB	20	24	22			
BD-CEJ	50	50	50			
BD-CCT	12	13	12.5			
BD-AB	27	27	27			
Animal 4	Slide 1	Slide 2	Average	Slide 1	Slide 2	Average
GM-SB	-	-	-	7	7	7
SB-CCT	-	-	-	15	13	14
CCT-AB	-	-	-	35	35	35
BD-GM	-	-	-			
BD-SB	-	-	-			
BD-CEJ	-	-	-			
BD-CCT	-	-	-			
BD-AB	-	-	-			
Animal 5	Slide 1	Slide 2	Average	Slide 1	Slide 2	Average
GM-SB	5	5	5	5	5	5
SB-CCT	23	25	24	15	15	15
CCT-AB	25	27	26	20	20	20
BD-GM	35	33	34			
BD-SB	30	28	29			
BD-CEJ	55	53	54			
BD-CCT	2	3	2.5			
BD-AB	19	19	19			

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Units = 20 microns

GROUP D WEEK 6

Animal 1	Right Side Slide 1	Right Side Slide 2	Right Side Average	Left Side Slide 1	Left Side Slide 2	Left Side Average
GM-SB	6	6	6	10	10	10
SB-CCT	22	20	21	21	21	21
CCT-AB	26	25	25.5	40	40	40
BD-GM	32	30	31			
BD-SB	27	25	26			
BD-CEJ	46	45	45.5			
BD-CCT	4	3	3.5			
BD-AB	22	24	23			

Animal 2	Right Side Slide 1	Right Side Slide 2	Right Side Average	Left Side Slide 1	Left Side Slide 2	Left Side Average
GM-SB	-	-	-	13	15	14
SB-CCT	-	-	-	18	18	18
CCT-AB	-	-	-	38	40	39
BD-GM	-	-	-			
BD-SB	-	-	-			
BD-CEJ	-	-	-			
BD-CCT	-	-	-			
BD-AB	-	-	-			

Animal 3	Right Side Slide 1	Right Side Slide 2	Right Side Average	Left Side Slide 1	Left Side Slide 2	Left Side Average
GM-SB	5	5	5	10	10	10
SB-CCT	29	28	28.5	30	32	31
CCT-AB	31	33	32	26	25	25.5
BD-GM	34	34	34			
BD-SB	29	29	29			
BD-CEJ	53	53	53			
BD-CCT	0	0	0			
BD-AB	32	32	32			

Animal 4	Right Side Slide 1	Right Side Slide 2	Right Side Average	Left Side Slide 1	Left Side Slide 2	Left Side Average
GM-SB	5	5	5	15	13	14
SB-CCT	24	23	23.5	22	22	22
CCT-AB	45	44	44.5	37	41	39
BD-GM	35	36	35.5			
BD-SB	30	31	30.5			
BD-CEJ	43	44	43.5			
BD-CCT	6	6	6			
BD-AB	38	37	37.5			

Animal 5	Right Side Slide 1	Right Side Slide 2	Right Side Average	Left Side Slide 1	Left Side Slide 2	Left Side Average
GM-SB	8	7	7.5	17	16	16.5
SB-CCT	13	15	14	22	22	22
CCT-AB	40	40	40	30	28	29
BD-GM	35	35	35			
BD-SB	27	28	27.5			
BD-CEJ	32	32	32			
BD-CCT	12	13	22.5			
BD-AB	25	25	25			

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GROUP D WEEK 12

Animal 1	Right Side Slide 1	Right Side Slide 2	Right Side Average	Left Side Slide 1	Left Side Slide 2	Left Side Average
GM-SB	7	7	7	7	7	7
SB-CCT	33	35	34	32	31	31.5
CCT-AB	38	35	36.5	30	32	31
BD-GM	49	48	48.5			
BD-SB	42	41	41.5			
BD-CEJ	49	49	49			
BD-CCT	14	13	13.5			
BD-AB	23	22	22.5			

Animal 2	Right Side Slide 1	Right Side Slide 2	Right Side Average	Left Side Slide 1	Left Side Slide 2	Left Side Average
GM-SB	10	10	10	19	19	19
SB-CCT	25	26	25.5	25	26	25.5
CCT-AB	36	35	35.5	28	27	27.5
BD-GM	60	60	60			
BD-SB	50	50	50			
BD-CEJ	60	60	60			
3D-CCT	23	23	23			
BD-AB	12	12	12			

Animal 3	Right Side Slide 1	Right Side Slide 2	Right Side Average	Left Side Slide 1	Left Side Slide 2	Left Side Average
GM-SB	15	15	15	-	-	-
SB-CCT	13	13	13	-	-	-
CCT-AB	42	42	42	-	-	-
BD-GM	31	30	30.5			
BD-SB	16	15	15.5			
BD-CEJ	40	40	40			
BD-CCT	2	3	2.5			
BD-AB	39	39	39			

Animal 4	Right Side Slide 1	Right Side Slide 2	Right Side Average	Left Side Slide 1	Left Side Slide 2	Left Side Average
GM-SB	7	7	7	10	10	10
SB-CCT	45	45	45	27	22	26.5
CCT-AB	32	35	33.5	50	50	50
BD-GM	50	50	50			
BD-SB	43	43	43			
BD-CEJ	50	50	50			
BD-CCT	0	0	0			
BD-AB	32	35	33.5			

Animal 5	Right Side Slide 1	Right Side Slide 2	Right Side Average	Left Side Slide 1	Left Side Slide 2	Left Side Average
GM-SB	12	11	11.5	10	12	11
SB-CCT	16	14	15	25	24	24.5
CCT-AB	42	42	42	37	38	37.5
BD-GM	31	30	30.5			
BD-SB	19	16	17.5			
BD-CEJ	50	45	47.5			
BD-CCT	4	4	4			
BD-AB	38	39	38.5			

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Units = 20 microns

GROUP E DAY 1

Animal 1	Right Slide 1	Right Slide 2	Right Average	Left Slide 1	Left Slide 2	Left Average
GM-SB	-	-	-	8	8	8
SB-CCT	-	-	-	24	28	26
CCT-AB	-	-	-	35	35	35
BD-GM	-	-	-			
BD-SB	-	-	-			
BD-CEJ	55	55	55			
BD-CCT	0	0	0			
BD-AB	10	10	10			

Animal 2	Right Slide 1	Right Slide 2	Right Average	Left Slide 1	Left Slide 2	Left Average
GM-SB	-	-	-	8	10	9
SB-CCT	-	-	-	12	15	13.5
CCT-AB	-	-	-	57	55	56
BD-GM	-	-	-			
BD-SB	-	-	-			
BD-CEJ	65	67	66			
BD-CCT	0	0	0			
BD-AB	8	8	8			

Animal 3	Right Slide 1	Right Slide 2	Right Average	Left Slide 1	Left Slide 2	Left Average
GM-SB	-	-	-	12	12	12
SB-CCT	-	-	-	32	30	31
CCT-AB	-	-	-	35	37	36
BD-GM	-	-	-			
BD-SB	-	-	-			
BD-CEJ	50	52	51			
BD-CCT	0	0	0			
BD-AB	19	19	19			

Animal 4	Right Slide 1	Right Slide 2	Right Average	Left Slide 1	Left Slide 2	Left Average
GM-SB	-	-	-	9	10	9.5
SB-CCT	-	-	-	19	21	20
CCT-AB	-	-	-	39	38	38.5
BD-GM	-	-	-			
BD-SB	-	-	-			
BD-CEJ	32	40	36			
BD-CCT	0	0	0			
BD-AB	20	18	19			

Animal 5	Right Slide 1	Right Slide 2	Right Average	Left Slide 1	Left Slide 2	Left Average
GM-SB	-	-	-	8	10	9
SB-CCT	-	-	-	18	17	17.5
CCT-AB	-	-	-	30	21	25.5
BD-GM	-	-	-			
BD-SB	-	-	-			
BD-CEJ	35	35	35			
BD-CCT	0	0	0			
BD-AB	12	14	13			

GM = Gingival Margin
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Units = 20 microns

GROUP E DAY 2

	RIGHT SIDE			LEFT SIDE		
Animal 1	Slide 1	Slide 2	Average	Slide 1	Slide 2	Average
GM-SB	-	-	-	10	10	10
SB-CCT	-	-	-	21	23	22
CCT-AB	-	-	-	40	36	38
BD-GM	-	-	-			
BD-SB	-	-	-			
BD-CEJ	47	53	50			
BD-CCT	0	0	0			
BD-AB	4	5	4.5			
Animal 2	Slide 1	Slide 2	Average	Slide 1	Slide 2	Average
GM-SB	-	-	-	10	10	10
SB-CCT	-	-	-	18	24	21
CCT-AB	-	-	-	40	40	40
BD-GM	-	-	-			
BD-SB	-	-	-			
BD-CEJ	53	53	53			
BD-CCT	0	0	0			
BD-AB	12	12	12			
Animal 3	Slide 1	Slide 2	Average	Slide 1	Slide 2	Average
GM-SB	-	-	-	-	-	-
SB-CCT	-	-	-	-	-	-
CCT-AB	-	-	-	-	-	-
BD-GM	-	-	-			
BD-SB	-	-	-			
BD-CEJ	55	60	57.5			
BD-CCT	0	0	0			
BD-AB	10	10	10			
Animal 4	Slide 1	Slide 2	Average	Slide 1	Slide 2	Average
GM-SB	-	-	-	15	15	15
SB-CCT	-	-	-	28	28	28
CCT-AB	-	-	-	32	32	32
BD-GM	-	-	-			
BD-SB	-	-	-			
BD-CEJ	60	60	60			
BD-CCT	0	0	0			
BD-AB	10	10	10			
Animal 5	Slide 1	Slide 2	Average	Slide 1	Slide 2	Average
GM-SB	-	-	-	10	8	9
SB-CCT	-	-	-	20	20	20
CCT-AB	-	-	-	25	25	25
BD-GM	-	-	-			
BD-SB	-	-	-			
BD-CEJ	43	45	44			
BD-CCT	0	0	0			
BD-AB	13	15	14			

GM = Gingival Margin
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BD = Base of Defect
CEJ = Cemento-Enamel Junction
Units = 20 microns

GROUP E DAY 3

	RIGHT SIDE			LEFT SIDE		
Animal 1	Slide 1	Slide 2	Average	Slide 1	Slide 2	Average
GM-SB	-	-	-	10	10	10
SB-CCT	-	-	-	15	15	15
CCT-AB	-	-	-	20	10	15
BD-GM	-	-	-			
BD-SB	-	-	-			
BD-CEJ	45	40	42.5			
BD-CCT	0	0	0			
BD-AB	8	18	13			
Animal 2	Slide 1	Slide 2	Average	Slide 1	Slide 2	Average
GM-SB	-	-	-	17	17	17
SB-CCT	-	-	-	26	22	24
CCT-AB	-	-	-	33	30	31.5
BD-GM	-	-	-			
BD-SB	-	-	-			
BD-CEJ	50	50	50			
BD-CCT	0	0	0			
BD-AB	14	14	14			
Animal 3	Slide 1	Slide 2	Average	Slide 1	Slide 2	Average
GM-SB	-	-	-	12	14	12
SB-CCT	-	-	-	18	21	19.5
CCT-AB	-	-	-	35	30	32.5
BD-GM	-	-	-			
BD-SB	-	-	-			
BD-CEJ	55	55	55			
BD-CCT	0	0	0			
BD-AB	15	15	15			
Animal 4	Slide 1	Slide 2	Average	Slide 1	Slide 2	Average
GM-SB	-	-	-	11	11	11
SB-CCT	-	-	-	20	20	20
CCT-AB	-	-	-	31	30	30.5
BD-GM	-	-	-			
BD-SB	-	-	-			
BD-CEJ	50	50	50			
BD-CCT	0	0	0			
BD-AB	10	0	5			
Animal 5	Slide 1	Slide 2	Average	Slide 1	Slide 2	Average
GM-SB	-	-	-	10	9	9.5
SB-CCT	-	-	-	15	17	16
CCT-AB	-	-	-	33	33	33
BD-GM	-	-	-			
BD-SB	-	-	-			
BD-CEJ	35	35	35			
BD-CCT	5	0	2.5			
BD-AB	12	10	11			

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GROUP E WEEK 1

Animal 1	Right Side Slide 1	Right Side Slide 2	Right Side Average	Left Side Slide 1	Left Side Slide 2	Left Side Average
GM-SB	2	2	2	10	6	8
SB-CCT	11	10	10.5	20	18	19
CCT-AB	30	30	30	35	30	32.5
BD-GM	29	26	27.5			
BD-SB	27	24	25.5			
BD-CEJ	53	51	52			
BD-CCT	15	11	13			
BD-AB	14	16	15			

Animal 2	Right Side Slide 1	Right Side Slide 2	Right Side Average	Left Side Slide 1	Left Side Slide 2	Left Side Average
GM-SB	-	-	-	7	7	7
SB-CCT	-	-	-	18	18	18
CCT-AB	-	-	-	35	33	34
BD-GM	-	-	-			
BD-SB	-	-	-			
BD-CEJ	-	-	-			
BD-CCT	-	-	-			
BD-AB	-	-	-			

Animal 3	Right Side Slide 1	Right Side Slide 2	Right Side Average	Left Side Slide 1	Left Side Slide 2	Left Side Average
GM-SB	3	2	2.5	10	10	10
SB-CCT	13	13	13	22	25	23.5
CCT-AB	32	34	33	40	40	40
BD-GM	24	28	26			
BD-SB	22	25	23.5			
BD-CEJ	50	50	50			
BD-CCT	9	11	10			
BD-AB	24	24	24			

Animal 4	Right Side Slide 1	Right Side Slide 2	Right Side Average	Left Side Slide 1	Left Side Slide 2	Left Side Average
GM-SB	7	7	7	10	9	9.5
SB-CCT	20	25	22.5	18	21	19.5
CCT-AB	85	78	81.5	46	47	46.5
BD-GM	90	92	91			
BD-SB	82	85	83.5			
BD-CEJ	82	85	83.5			
BD-CCT	60	62	61			
BD-AB	23	17	20			

Animal 5	Right Side Slide 1	Right Side Slide 2	Right Side Average	Left Side Slide 1	Left Side Slide 2	Left Side Average
GM-SB	2	1	1.5	8	9	8.5
SB-CCT	15	11	14	18	19	18.5
CCT-AB	28	31	29.5	42	40	41
BD-GM	16	16	16			
BD-SB	15	15	15			
BD-CEJ	45	45	45			
BD-CCT	0	4	2			
BD-AB	29	28	28.5			

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GROUP E WEEK 2

Animal 1	RIGHT SIDE Slide 1	RIGHT SIDE Slide 2	RIGHT SIDE Average	LEFT SIDE Slide 1	LEFT SIDE Slide 2	LEFT SIDE Average
GM-SB	19	15	17	5	6	5.5
SB-CCT	7	9	8	25	28	26.5
CCT-AB	35	36	35.5	33	33	33
BD-GM	30	28	29			
BD-SB	11	11	11			
BD-CEJ	51	50	50.5			
BD-CCT	3	2	2.5			
BD-AB	32	32	32			

Animal 2	RIGHT SIDE Slide 1	RIGHT SIDE Slide 2	RIGHT SIDE Average	LEFT SIDE Slide 1	LEFT SIDE Slide 2	LEFT SIDE Average
GM-SB	6	2	4	10	8	9
SB-CCT	18	24	21	19	17	18
CCT-AB	34	32	33	42	40	41
BD-GM	36	37	36.5			
BD-SB	30	35	32.5			
BD-CEJ	45	45	45			
BD-CCT	11	11	11			
BD-AB	24	22	23			

Animal 3	RIGHT SIDE Slide 1	RIGHT SIDE Slide 2	RIGHT SIDE Average	LEFT SIDE Slide 1	LEFT SIDE Slide 2	LEFT SIDE Average
GM-SB	2	2	2	8	10	9
SB-CCT	21	23	22	12	17	14.5
CCT-AB	54	54	54	30	35	33.5
BD-GM	51	51	51			
BD-SB	49	49	49			
BD-CEJ	51	55	53			
BD-CCT	27	26	26.5			
BD-AB	28	30	29			

Animal 4	RIGHT SIDE Slide 1	RIGHT SIDE Slide 2	RIGHT SIDE Average	LEFT SIDE Slide 1	LEFT SIDE Slide 2	LEFT SIDE Average
GM-SB	3	2	2.5	11	11	11
SB-CCT	14	15	14.5	15	14	14.5
CCT-AB	40	40	40	36	37	36.5
BD-GM	33	31	32			
BD-SB	30	29	29.5			
BD-CEJ	45	40	42.5			
BD-CCT	16	13	14.5			
BD-AB	25	28	26.5			

Animal 5	RIGHT SIDE Slide 1	RIGHT SIDE Slide 2	RIGHT SIDE Average	LEFT SIDE Slide 1	LEFT SIDE Slide 2	LEFT SIDE Average
GM-SB	5	4	4.5	10	10	10
SB-CCT	10	6	8	18	17	17.5
CCT-AB	36	40	38	34	35	34.5
BD-GM	25	28	26.5			
BD-SB	21	24	22.5			
BD-CEJ	40	42	41			
BD-CCT	10	17	13.5			
BD-AB	25	21	23.5			

GM = Gingival Margin
SB = Sulcus Base
CCT = Most Coronal Connective Tissue
AB = Alveolar Bone
BD = Base of Defect
CEJ = Cemento-Enamel Junction
Units = 20 microns

GROUP E WEEK 3

Animal 1	Right Slide 1	Right Slide 2	Right Average	Left Slide 1	Left Slide 2	Left Average
GM-SB	5	5	5	13	13	13
SB-CCT	21	20	20.5	17	17	17
CCT-AB	39	38	38.5	34	35	34.5
BD-GM	45	45	45			
BD-SB	40	40	40			
BD-CEJ	58	60	59			
BD-CCT	21	21	21			
BD-AB	19	17	18			

Animal 2	Right Slide 1	Right Slide 2	Right Average	Left Slide 1	Left Slide 2	Left Average
GM-SB	5	5	5	11	10	10.5
SB-CCT	12	12	12	19	24	21.5
CCT-AB	37	37	37	35	35	35
BD-GM	32	34	33			
BD-SB	27	29	28			
BD-CEJ	37	43	40			
BD-CCT	15	16	15.5			
BD-AB	21	22	21.5			

Animal 3	Right Slide 1	Right Slide 2	Right Average	Left Slide 1	Left Slide 2	Left Average
GM-SB	5	3	4	10	10	10
SB-CCT	10	12	11	19	20	19.5
CCT-AB	38	38	38	33	32	32.5
BD-GM	30	30	30			
BD-SB	25	27	26			
BD-CEJ	40	42	41			
BD-CCT	15	15	15			
BD-AB	24	23	23.3			

Animal 4	Right Slide 1	Right Slide 2	Right Average	Left Slide 1	Left Slide 2	Left Average
GM-SB	5	8	6.5	21	21	21
SB-CCT	25	19	22.5	15	11	13
CCT-AB	38	42	40	45	45	45
BD-GM	50	49	49.5			
BD-SB	45	41	43			
BD-CEJ	50	55	52.5			
BD-CCT	20	22	21			
BD-AB	19	20	19.5			

Animal 5	Right Slide 1	Right Slide 2	Right Average	Left Slide 1	Left Slide 2	Left Average
GM-SB	7	4	5.5	10	8	9
SB-CCT	27	31	29	20	20	20
CCT-AB	35	35	35	37	37	37
BD-GM	44	45	44.5			
BD-SB	37	41	39			
BD-CEJ	52	50	51			
BD-CCT	10	10	10			
BD-AB	25	25	25			

GM = Gingival Margin
SB = Sulcus Base
CCT = Most Coronal Connective Tissue
AB = Alveolar Bone
BD = Base of Defect
CEJ = Cemento-Enamel Junction
Units = 20 microns

GROUP E WEEK 6

	RIGHT SIDE			LEFT SIDE		
Animal 1	Slide 1	Slide 2	Average	Slide 1	Slide 2	Average
GM-SB	10	12	11	13	13	13
SB-CCT	20	19	19.5	27	25	26
CCT-AB	50	50	50	32	34	33
BD-GM	50	52	51			
BD-SB	40	40	40			
BD-CEJ	51	50	50.5			
BD-CCT	21	20	20.5			
BD-AB	30	30	30			
Animal 2	Slide 1	Slide 2	Average	Slide 1	Slide 2	Average
GM-SB	-	-	-	9	10	9.5
SB-CCT	-	-	-	15	15	15
CCT-AB	-	-	-	36	37	36.5
BD-GM	-	-	-			
BD-SB	-	-	-			
BD-CEJ	-	-	-			
BD-CCT	-	-	-			
BD-AB	-	-	-			
Animal 3	Slide 1	Slide 2	Average	Slide 1	Slide 2	Average
GM-SB	5	5	5	8	5	6.5
SB-CCT	23	25	24	25	24	24.5
CCT-AB	43	42	42.5	39	40	39.5
BD-GM	48	48	48			
BD-SB	43	43	43			
BD-CEJ	60	62	61			
BD-CCT	18	18	18			
BD-AB	25	25	25			
Animal 4	Slide 1	Slide 2	Average	Slide 1	Slide 2	Average
GM-SB	10	10	10	17	17	17
SB-CCT	22	20	21	34	32	33
CCT-AB	36	35	35.5	43	43	43
BD-GM	49	46	47.5			
BD-SB	39	36	37.5			
BD-CEJ	38	40	39			
BD-CCT	16	16	16			
BD-AB	20	20	20			
Animal 5	Slide 1	Slide 2	Average	Slide 1	Slide 2	Average
GM-SB	9	7	8	10	10	10
SB-CCT	27	30	28.5	17	17	17
CCT-AB	42	40	41	50	60	55
BD-GM	50	48	49			
BD-SB	40	41	40.5			
BD-CEJ	41	42	41.5			
BD-CCT	12	10	11			
BD-AB	30	30	30			

GM = Gingival Margin
SB = Sulcus Base
CCT = Most Coronal Connective Tissue
AB = Alveolar Bone
BD = Base of Defect
CEJ = Cemento-Enamel Junction
Units = 20 microns

GROUP E WEEK 12

Animal 1	Right Slide 1	Right Slide 2	Right Average	Left Slide 1	Left Slide 2	Left Average
GM-SB	12	10	11	10	10	10
SB-CCT	12	10	11	25	23	24
CCT-AB	35	38	36.5	31	35	33
BD-GM	26	32	29			
BD-SB	14	22	18			
BD-CEJ	50	50	50			
BD-CCT	2	12	7			
BD-AB	35	27	31			

Animal 2	Right Slide 1	Right Slide 2	Right Average	Left Slide 1	Left Slide 2	Left Average
GM-SB	10	10	10	-	-	-
SB-CCT	16	15	15.5	-	-	-
CCT-AB	35	35	35	-	-	-
BD-GM	38	38	38			
BD-SB	28	28	28			
BD-CEJ	59	65	62			
BD-CCT	11	12	11.5			
BD-AB	24	23	23.5			

Animal 3	Right Slide 1	Right Slide 2	Right Average	Left Slide 1	Left Slide 2	Left Average
GM-SB	16	20	18	7	9	8
SB-CCT	21	17	19	18	18	18
CCT-AB	39	36	37.5	27	29	28
BD-GM	42	42	42			
BD-SB	26	22	24			
BD-CEJ	48	50	49			
BD-CCT	5	6	5.5			
BD-AB	33	30	31.5			

Animal 4	Right Slide 1	Right Slide 2	Right Average	Left Slide 1	Left Slide 2	Left Average
GM-SB	10	12	11	13	15	14
SB-CCT	21	17	19	23	23	23
CCT-AB	41	37	39	31	31	31
BD-GM	35	35	35			
BD-SB	25	22	23.5			
BD-CEJ	44	40	42			
BD-CCT	10	5	7.5			
BD-AB	32	33	32.5			

Animal 5	Right Slide 1	Right Slide 2	Right Average	Left Slide 1	Left Slide 2	Left Average
GM-SB	8	5	6.5	11	10	10.5
SB-CCT	15	19	17	25	25	25
CCT-AB	35	35	35	45	45	45
BD-GM	26	26	26			
BD-SB	18	21	19.5			
BD-CEJ	50	50	50			
BD-CCT	2	2	2			
BD-AB	33	32	32.5			

GM = Gingival Margin
SB = Sulcus Base
CCT = Most Coronal Connective Tissue
AB = Alveolar Bone
BD = Base of Defect
CEJ = Cemento-Enamel Junction
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LITERATURE CITED

Aleo, J. J., De Renzis, F. A. and Farber, P. A. 1975. In Vitro Attachment of Human Gingival Fibroblasts to Root Surfaces. J. Periodontol. 46:639.

Armed Forces Institute of Pathology, 1968. Manual of Histologic Staining Methods 3rd Ed. McGraw-Hill Publishers, New York. page 7.

Armitage, G. S., Svanberg, G. K. and Loe, H. 1977. Microscopic Evaluation of Clinical Measurements of Connective Tissue Attachment Levels. J. Clin. Perio. 4:173.

Barrington, E. P. 1981. An Overview of Periodontal Surgical Procedures. J. Periodontol. 52:518.

Beaumont, R. H., O'Leary, T. J., and Kafrawy, A. H. 1984. Relative Resistance of Long Junctional Epithelial Adhesions and Connective Tissue Attachments to Plaque-Induced Inflammation. J. Periodontol. 55:213.

Borregaard, N. and Kragballe, K. 1982. The Oxygen-dependent Antibody-dependent Cell-mediated Cytotoxicity of Human Monocytes and Neutrophils. Adv. Exp. Med. Biol. 141:71.

Bowers, G. M., Schallhorn, R. G. and Mellonig, J. T. 1982. Histologic Evaluation of New Attachment in Human Intrabony Defects. J. Periodontol. 53:509.

Bowers, G. M., Granet, M., Stevens, M., Emerson, J., Russel, C., Mellonig, J., Lewis, S. B., Peltzman, B., Romberg, E. and Risom, L. 1985. Histologic Evaluation of New Attachment in Humans. J. Periodontol. 56:381.

Brown, G. L., Thompson, P. D., Mader, J. T., Hilton, J. G., Browne, M. E. and Wells, C. H. 1979. Effects of Hyperbaric Oxygen Upon *S. aureus*, *Ps. aeroginosa* and *C. albicans*. Aviation, Space and Environmental Medicine. page 717.

Cafesse, R. G., Holden, M. J., Kon, S. and Nasjleti, C. E. 1985. The Effect of Citric Acid and Fibronectin Application on Healing Following Surgical Treatment of Naturally Occurring Periodontal Disease in Beagle Dogs. J. Clin. Perio. 12:578.

Caton, J. G. and Zander, H. A. 1979. The Attachment Between Tooth and Gingival Tissues After Periodic Root Planing and Soft Tissue Curettage. J. Periodontol. 50:462.

Caton, J. G. and Nyman, S. 1980a. Histometric Evaluation of Periodontal Surgery. I. The Modified Widman Flap Procedure. J. Clin. Perio. 7:212.

Caton, J. G., Nyman, S. and Zander, H. A. 1980b. Histometric Evaluation of Periodontal Surgery. II. Connective Tissue Attachment Levels After Four Regenerative Procedures. J. Clin. Perio. 7:224.

Clark, J. M. and Fisher, A. B. 1977. Oxygen Toxicity and Extension of Tolerance in Oxygen Therapy. Hyperbaric Oxygen Therapy. J. C. Davis and T. K. Hunt (eds.) Undersea Medical Society, Bethesda, Maryland. page 61.

Cole, R. T., Crigger, M., Bogle, G., Egelberg, J. and Selvig, K. A. 1980. Connective Tissue Regeneration to Periodontally Diseased Teeth. J. Perio. Res. 15:1.

Davis, J. C., Dunn, J. M., Gates, G. A. and Heimbach, R. D. 1979. Hyperbaric Oxygen-A New Adjunct in the Management of Radiation Necrosis. Arch. Otolaryngol. 105:58.

Davis, J. C. and Hunt, T. K. (eds.) 1977. Hyperbaric Oxygen Therapy. Undersea Medical Society, Bethesda, Maryland.

Deneke, S. M. and Fanburg, B. L. 1980. Normobaric Oxygen Toxicity of the Lung. New England J. of Medicine. 303:76.

Dunlop, W. 1938. The Dunlop Method in Periodontal Therapeutics. Hammond Hardy Publishing, Detroit.

Ellegaard, H., Karring, T. and Loe, H. 1976. Retardation of epithelial Migration in New Attachment Attempts in Intrabony Defects in Monkeys. J. Clin. Perio. 3:23.

Frank, R. and Fiore-Donno, G. 1972. Gingival Reattachment After Surgery in Man. J. Periodontol. 43:597.

Frank, R., Fiore-Donno, G., Cimasoni, G. and Matter, J. 1974. Ultrastructural Study of Epithelial and Connective Gingival Reattachment in Man. J. Periodontol. 45:626.

Froum, S. J., Kushner, L. and Stahl, S. S. 1983. Healing Responses of Human Intraosseous Lesions Following the Use of Debridement, Grafting and Citric Acid Root Treatment. J. Periodontol. 54:67.

Garrett, S., Bogle, G., Adams, D. and Egelberg, J. 1981. The Effect of Notching into Dentin on New Cementum Formation During Periodontal Wound Healing. J. Perio. Research 16:358.

Glass, M., Kaplan, J. E., Macarak, E., Aukberg, S. J. and Fisher, A. B. 1984. Serum Fibronectin is Elevated During Normobaric and Hyperbaric Oxygen Exposure in Rats. Am. Rev. Respir. Dis. 130:237.

Glickman, I., Turesky, S. and Hill, R. 1949. Determination of Oxygen Consumption in Normal and Inflamed Human Gingiva Using the Warburg manometric technic. J. Dent. Res. 28:83.

Gotsko, E. V. 1980. Experience in Using Hyperbaric Oxygenation in the Overall Treatment of Parodontitis. Stomatologiia. 59:23.

Gottlieb, S. F. 1977. Oxygen Under Pressure and Microorganisms. Hyperbaric Oxygen Therapy. J. C. Davis and T. K. Hunt (eds.) Undersea Med. Soc. Bethesda, Maryland. page 79.

Gottlow, J., Nyman, S., Karring, T. and Lindhe, J. 1984. New Attachment Formation as the Result of Controlled Tissue Regeneration. J. Clin. Perio. 11:494.

Greenwood, T. W. and Gilchrist, A. G. 1973. Hyperbaric Oxygen and Wound Healing in Post-irradiation Head and Neck Surgery. Brit. J. Surg. 60:394.

Hiatt, W. H., Stallard, R. E., Butler, E. D. and Badgett, B. 1968. Repair Following Mucoperiosteal Flap Surgery With Full Gingival Retention. J. Periodontol. 39:11.

Hohn, D. C. 1977. Oxygen and Leukocyte Microbial Killing. Hyperbaric Oxygen Therapy. J. C. Davis and T. K. Hunt (eds.) Undersea Med. Soc. Bethesda, Maryland. page 101.

Houston, F., Sarhed, G., Nyman, S., Lindhe, J. and Karring, T. 1985. Healing After Root Reimplantation in the Monkey. J. Clin. Perio. 12:716.

Hunt, T. K., Niinikoski, J., Zederfeldt, B. H. and Silver, I. A. 1977. Oxygen in Wound Healing Enhancement: Cellular Effects of Oxygen. Hyperbaric Oxygen Therapy. J. C. Davis and T. K. Hunt (eds.) Undersea Med. Soc. Bethesda, Maryland. page 111.

Hunt, T. K. and Pai, M. P. 1972. The Effect of Varying

Ambient Oxygen Tensions on Wound Healing Metabolism and Collagen Synthesis. Surg. Gynecol. Obstet. 135:561.

Hunt, T. K., Twomey, P., Zederfeldt, B. and Dunphy, J. E. 1967. Respiratory Gas Tensions and pH in Healing Wounds. Amer. J. Surg. 114:302.

Hunt, T. K., Zederfeldt, B. and Goldstick, T. K. 1969. Oxygen and Healing. Amer. J. Surg. 118:521.

Ivanov, V. S. and Urlina, L. I. 1979. Treatment of the dystrophic inflammatory form of Parodontosis. Stomatologiia. 61:214.

Karring, T., Nyman, S. and Lindhe, J. 1980. Healing Following Implantation of Periodontitis Affected Roots into Bone Tissue. J. Clin. Perio. 7:96.

Karring, T., Nyman, S., Lindhe, J., and Sirirat, M. 1984. Potentials for Root Resorption During Periodontal Wound Healing. J. Clin. Perio. 11:41.

Karring, T., Isisdor, F., Nyman, S. and Lindhe, J. 1985. New Attachment Formation on Teeth with a Reduced but Healthy Periodontal Ligament. J. Clin. Perio. 12:51.

Kerley, T. R., Mader, J. T., Hulet, W. H. and Schow. 1981. The Effect of Adjunctive Hyperbaric Oxygen on Bone Regeneration in Mandibular Osteomyelitis. J. Oral Surgery 39:619.

Klebanoff, S. J. 1982. Oxygen-dependent Cytotoxic Mechanisms of Phagocytes. J. I. Gallin and A. S. Fauci (eds.) Advances in Host Defense Mechanisms, page 111. Raven Press, New York.

Klinge, B., Nilveus, R. and Egelberg, J. 1985. Bone Regeneration Pattern and Ankylosis in Experimental Furcation Defects in Dogs. J. Clin. Perio. 12:456.

Korn, H. K., Wheeler, E. S. and Miller, T. A. 1977. Effect of Hyperbaric Oxygen on Second-degree Burn Wound Healing. Arch. Surg. 112:732.

Kulenen, E., Niinikoski, J. and Penttinen, R. 1967. Effect of the Supply of Oxygen on the Tensile Strength of Healing Skin Wound and Granulation Tissue. Acta Physiol. Scand. 70:112.

Levine, H. L. and Stahl, S. S. 1972. Repair Following Periodontal Flap Surgery with the Retention of Gingival Fibers. J. Periodontol. 43:99.

Lindhe, J. (ed.) 1983. Textbook of Clinical Periodontology. Munksgaard, Copenhagen. page 136.

Linghorne, W. J. and O'Connell, D. C. 1955. Studies in the Reattachment and Regeneration of the Supporting Structures of the Teeth III. Regeneration in Epithelialized Pockets. J. Dent. Res. 34:164.

Listgarten, M. A. 1972. Ultrastructure of the Dentogingival Junction After Gingivectomy. J. Perio. Res. 7:151.

Listgarten, M. A. 1976. Structure of the Microbial Flora Associated with Periodontal Health and Disease in Man. A Light and Electron Microscopic Study. J. Periodontol. 47:1.

Listgarten, M. A. and Rosenberg, M. M. 1979. Histological Study of Repair Following New Attachment Procedures in Human Periodontal Lesions. J. Periodontol. 50:333.

Listgarten, M. A., Rosenberg, S. and Lerner, S. 1982. Progressive Replacement of Epithelial Attachment by a Connective Tissue Junction After Experimental Periodontal Surgery in Rats. J. Periodontol. 53:659.

Lopez, N. J. 1984. Connective Tissue Regeneration to Periodontally Diseased Roots, Planed and Conditioned With Citric Acid and Implanted Into the Oral Mucosa. J. Periodontol. 55:381.

Lundgren, C. and Sandberg, N. 1965. Influence of Hyperbaric Oxygen on the Tensile Strength of Healing Skin Wounds in Rats. Hyperbaric Oxygenation Proceedings of 2nd International Congress. I. M. Ledingham (ed.) E. & S. Livingstone Ltd., London. page 393.

MacInnis, E. L. 1982. Hyperbaric Oxygen Therapy in Oral Surgery. The Canadian Forces Dental Services Bulletin. 2:2.

Magnusson, I., Runstad, L., Nyman, S. and Lindhe, J. 1983. A Long Junctional Epithelium-A locus Minoris Resistentiae in Plaque Infection? J. Clin. Perio. 10:333.

Mansfield, M. J., Sanders, D. W., Heimbach, R. D. and Marx, R. E. 1981. Hyperbaric Oxygen as an Adjunct in the Treatment of Osteoradionecrosis of the Mandible. J. Oral Surgery. 39:585.

Marfino, N. R., Orban, B. J. and Wentz, F. M. 1959. Repair of the Dento-Gingival Junction Following Surgical Intervention. J. Periodontol. 30:180.

Marikova, Z. 1983. Ultrastructure of Normal and Newly Formed Dento-Epithelial Junction In Rats. J. Perio. Res. 18:459.

Marx, R. E. 1983. Osteoradionecrosis: A New Concept of Its Pathophysiology. J. Oral and Maxillofacial Surgery. 41:283.

Marx, R. E. and Ames, J. R. 1982. The Use of Hyperbaric Oxygen Therapy in Bony Reconstruction of the Irradiated and Tissue-Deficient Patient. J. Oral and Maxillofacial Surgery. 40:412.

Marx, R. E., Johnson, R. P. and Kline, S. N. 1985. Prevention of Osteoradionecrosis: A Randomized Prospective Clinical Trial of Hyperbaric Oxygen versus Penicillin. J. Amer. Dent. Assoc. 111:49.

Mettraux, G. R., Gusberti, F. A. and Graf, H. 1984. Oxygen Tension in Untreated Human Periodontal Pockets. J. Periodontol. 55:516.

Morrey, B. F., Dunn, J. M., Heimbach, R. D. and Davis, J. C. 1979. Hyperbaric Oxygen and Chronic Osteomyelitis. Clin. Orthopaedics and Related Research. 144:121.

Moskow, B. S., Karsh, F. and Stein, S. D. 1979. Histological Assessment of Autogenous Bone Graft. A Case Report and Critical Evaluation. J. Periodontol. 50:298.

Myers, R. A. M., Snyder, S. K., Linberg, S. and Cowley, R. A. 1981. Value of Hyperbaric Oxygen in Suspected Carbon Monoxide Poisoning. J. Amer. Med. Assoc. 246:2478.

Niccole, M. W., Thornton, J. W., Danet, R. T., Bartlett, R. H. and Tavis, M. J. 1977. Hyperbaric Oxygen in Burn Management: A controlled Study. Surgery. 82:727.

Niinikoski, J., Hunt, T. K. and Dunphy, J. E. 1972. Oxygen Supply in Healing Tissue. Amer. J. Surg. 123:247.

Niinikoski, J., Penttinen, R. and Kulonen, E. 1966. Effect of Oxygen Supply on the Tensile Strength of Healing Wound and of Granulation Tissue. Acta Physiol. Scand. 68:146.

Niinikoski, J., Penttinen, R. and Kulonen, E. 1970. Effect of Hyperbaric Oxygenation on Fracture Healing in the Rat: A Biochemical Study. Calc. Tiss. Res. 4:115.

Nishiki, K., Jamieson, D., Oshino, N. and Chance, B. 1976. Oxygen Toxicity in the Perfused Rat Liver and Lung Under Hyperbaric Conditions. Biochem. J. 160:334.

Nyman, S., Gottlow, J., Karring, T. and Lindhe, J. 1982a. The Regenerative Potential of the Periodontal Ligament. J. Clin. Perio. 9:257.

Nyman, S., Houston, F., Sarhed, G., Lindhe, J. and Karring, T. 1985. Healing Following Reimplantation of Teeth Subjected to Root Planing and Citric Acid Treatment. J. Clin. Perio. 12:294.

Nyman, S., Lindhe, J., Karring, T. and Rylander, H. 1982b. New Attachment following Surgical Treatment of Human Periodontal Disease. J. Clin. Perio. 9:290.

Orban, B. J. 1942. Action of Oxygen on Chronically Inflamed Gingiva. J. Amer. Dent. Assoc. 29:2018.

Remensnyder, J. P. and Majno, G. 1968. Oxygen Gradients in Healing Wounds. Amer. J. Pathology 52:301.

Sabag, N., Mery, C., Garcia, M., Vasquez, V. and Cueto, V. 1985. Epithelial Reattachment After Gingivectomy in the Rat. J. Periodontol. 55:135.

Scottish Health Services Council. 1969. Uses and Dangers of Oxygen Therapy. Her Majesty's Stationery Office. Edinburg, Scotland. page 9.

Shaw, J. L. and Bassett, C. A. 1967. The Effect of Varying Oxygen Concentrations on Osteogenesis and Embryonic Cartilage In Vitro. J. Bone Joint Surg. 49A:73.

Stahl, S. S. 1964. The Healing of A Gingival Wound in Protein Deprived Antibiotic-Supplemented Adult Rats. Oral Surg. Oral Med. Oral Path. 17:443.

Stahl, S. S. 1975. Nature of Healthy and Diseased Root Surfaces. J. Periodontol. 46:156.

Stahl, S. S. 1977a. Healing Following Simulated Fiber Retention Procedures in Rats. J. Periodontol. 48:67.

Stahl, S. S. 1977b. Repair Potential of the Soft Tissue-Root Interface. J. Periodontol. 48:545

Stahl, S. S. and Froum, S. J. 1977. Human Clinical and Histologic Repair Responses Following the Use of Citric Acid in Periodontal Therapy. J. Periodontol. 48:261.

Stahl, S. S., Slavkin, H. C., Yamada, L. and Levine, S. 1972. Speculations About Gingival Repair. J. Periodontol. 43:395.

Stahl, S. S. 1985. Periodontal Attachment in Health and Disease. J. Western Soc. of Periodontology Periodontal Abstracts. 33:147.

Stahl, S. S. and Tarnow, D. 1985. Root Resorption Leading to Linkage of Dentinal Collagen and Gingival Fibers? A Case Report. J. Clin. Perio. 12:399.

Stern, I. B. 1981. Current Concepts of the Dentogingival Junction: The Epithelial and Connective Tissue Attachments to the Tooth. J. Periodontol. 52:465.

Sumachev, V. I. 1983. Hyperbaric Oxygenation in the Combined Therapy of Periodontosis. Stomatologiia. 62:22.

Svoboda, P. J., Reeve, C. M. and Sheridan, P. J. 1984. Effect of Retention of Gingival Sulcular Epithelium on Attachment and Pocket Depth After Periodontal Surgery. J. Periodontol. 55:563.

Taylor, A. C. and Campbell, M. M. 1972. Reattachment of Gingival Epithelium to the Tooth. J. Periodontol. 43:281.

Triplett, R. G., Branham, G. B., Gillmore, J. D. and Lorber, M. 1982. Experimental Mandibular Osteomyelitis: Therapeutic Trials with Hyperbaric Oxygen. J. Oral and Maxillofac. Surg. 40:640.

Vaes, G. M. and Nichols, G. 1962. Oxygen Tension and the Control of Bone Cell Metabolism. Nature. 193:374.

Weinstein, L. and Barza, M. A. 1976. Current Concepts, Gas Gangrene. New England J. Med. 289:1129.

Wilcox, J. W., and Kolodny, S. C. 1976. Acceleration of Healing of Maxillary and Mandibular Osteotomies by Use of Hyperbaric Oxygen. Oral Surg. 41:423.

Wilderman, M. N., Wentz, F. M. and Orban, B. J. 1960. Histogenesis of Repair after Mucogingival Surgery. J. Periodontol. 31:283.

Wirthlin, M. R. 1981. The Current Status of New Attachment Therapy. J. Periodontol. 52:529.

Wirthlin, M. R. and Hancock, E. B. 1980. Biologic Preparation of Diseased Root Surfaces. J. Periodontol. 51:291.

Woodyard, S. G., Synder, A. J., Henley, G. and O'Neal, R. B. 1984. A Histometric Evaluation of the Effect of Citric Acid Preparation Upon Healing of Coronally Positioned Flaps in Non-human Primates. J. Periodontol. 55:203.

Yaffe, A., Ehrlich, J. and Shoshan, S. 1984. Restoration of Periodontal Attachment Employing Enriched Collagen Solution in the Dog. J. Periodontol. 55:623.

Yukna, R. A., Bowers, G. M., Lawrence, J. J. and Fedi, P. F. 1976. A. Clinical Study of Healing in Humans Following the Excisional New Attachment Procedure. J. Periodontol. 47:696.

Yumet, J. A. and Polson, A. M. 1985. Gingival Wound Healing in the Presence of Plaque-Induced Inflammation. J. Periodontol. 56:107.

VITA

Michael Dean Shannon was born August 14, 1953, in Rapid City, South Dakota, the son of Leslie Dean and Darlene McKibben Shannon. He attended local public school and graduated as the valedictorian of Rapid City Central High School in 1971. He attended the South Dakota School of Mines and Technology in Rapid City from 1971 to 1972, majoring in Chemical Engineering. In 1972, he transferred to the University of Iowa to begin pre-dental studies. He received a Bachelor of Science degree with highest distinction from the University of Iowa in May, 1974. At that time he took a reserve commission in the United States Air Force and entered the College of Dentistry at the University of Iowa in August, 1974. He received the Doctor of Dental Surgery degree in May, 1978 and was inducted into the Omicron Kappa Upsilon honor dental fraternity. He entered active duty in the United States Air Force Dental Corps in June, 1978 and completed the Dental General Practice Residency at the United States Air Force Regional Hospital, Eglin Air Force Base, Florida in 1979. He was then assigned as a general dental officer at Ellsworth Air Force Base, Rapid City, South Dakota from 1979 to 1983. In July, 1983, he began a periodontics residency through the combined program of the Wilford Hall United States Air Force Medical Center and the University of Texas Health Science Center at San Antonio, Texas.

On August 13, 1977 he married Dr. Rayanne Fenton Shannon in Bladensburg, Iowa. They have three children, Derek Michael, born April 19, 1980, Erin Anne, born January 21, 1983 and Emily Elizabeth, born January 24, 1986.

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